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Conscientiousness and Healthy Aging Workshop

Background Materials and Statements from November 2009 Workshop Participants

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Background Statement for Workshop on Conscientiousness and Healthy Aging

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I. Introduction

Research on personality and aging reveals reliable links between trajectories of personality traits and social, cognitive, and physical outcomes in late life (Caspi, Roberts, & Shiner, 2005; Ozer and Benet-Martinez, 2006). Notably, findings have emerged linking changes in personality over the lifecourse to critical health outcomes, including mortality (Mroczek and Spiro, 2007). Indeed, years before these distinctive trajectories take shape, personality measures—usually paper and pencil tests—can predict these trajectories, although with substantial imprecision. In one recent review, long term predictions account for considerably less than 5% of the total variance in longevity, marital and occupation success in midlife (Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007).

Among the most reliable of these traits is conscientiousness, which is usually measured by the NEO or a similar instrument (Costa & McCrae, 1995), and has at least these components: competence and self efficacy; personal organization; dutifulness and fulfilling obligations; achievement striving; self discipline; and deliberation. In longitudinal studies examining the effects of personality measured youth on health in mid-life and beyond, conscientiousness has emerged as a protective factor (Friedman et al., 1993, 1995; Friedman, 2000; Martin, Friedman & Schwartz, 2007; Hampson, Goldberg, Vogt, & Dubanoski, 2006, 2007). In addition, very high scores on conscientiousness, compared to very low ones, are prospectively associated with reduction in general cognitive declines as well as with a very substantial reduction in the risk of Alzheimer's disease (Wilson, Schneider, Arnold, Bienias, & Bennett, 2007). Since these predictions are achieved after controlling for education and a broad range of other risk and protective factors (including a comparable reduction in Alzheimer's pathology), a reasonable hypothesis is that high conscientiousness is associated with important, compensatory, neuroprotective mechanisms, through experience or genes.

There have been a few early starts on the translation of this research; studies have attempted use of this personality variable to improve effectiveness of behavioral interventions relevant to health and aging. That is, these studies have attempted to identify, a priori, subgroup of individuals who may benefit from intervention. However, these translational studies of conscientiousness have produced inconsistent results in predicting the success of a variety of behavioral interventions (Canuto, Meiler-Mititelu, Herrmann, Giannakopoulos, & Weber, 2008; Gully, Payne, Koles, & Whiteman, 2002; Moran, Christensen, & Lawton, 1997; Rhodes, Courneya, & Bobick, 2001). This early, and perhaps premature, application of these findings on personality to practical intervention suggest that we need to better understand the predictive power of this group of constructs before research can be applied to improvements in public health.

II. Background

The proposed roundtable on conscientiousness is designed to determine what new research would further our understanding of the links between conscientiousness and positive aging and to determine how these studies would open up the possibility for more effective preventive and therapeutic interventions. Therefore, this workshop is designed to focus discussion around five themes: (1) conceptualization and measurement of conscientiousness, (2) functional versus descriptive conceptualizations of personality, (3) pathways linking personality and health, (4) malleability or reversibility of personality features, and (5) role of genetics in understanding personality.

Conceptualization and Measurement of Conscientiousness.

First and foremost is a *better understanding of the construct itself*. Its measurement reflects a fundamental strategy in personality assessment whose limits are becoming more fully recognized. Personality measures in general, and the NEO system in particular, are efforts to characterize personality by descriptive phrases that regard individuals as differing in "dispositions" or probabilities of behavioral and emotional reactions across a broad variety of settings. The six components of conscientiousness are brought together for statistical reasons: they are correlated with each other more than with other descriptors and there is impressive, long term stability of each trait *and of their tendency to cluster.* The most impressive study to date suggest some continuity of this cluster from mid childhood to middle-adulthood, across a span of 40 years as well as the modest utility of this cluster, measured in childhood, to predict important health outcomes four decades later (Hampson & Goldberg, 2006; Hampson et al., 2006).

Mechanisms linking facets: genetic and developmental. However, quantitative genetic analysis has raised some of the most serious concerns as to whether there is a single underlying psychological or neurobiological process accounting for this clustering. Despite their statistical clustering, the components of conscientiousness are not likely to be associated with the same genes; thus several different biological mechanisms may underlie conscientiousness and—though correlated in some way—these distinctive mechanisms need to be separately identified (Johnson & Krueger, 2004). In addition, current psychometric methods suggest that only some of the "facets" of conscientiousness may be linked to particular outcomes of interest. One example is the particular link between the facet of self discipline and health-promoting behaviors (Hagger-Johnson & Whiteman, 2007).

These data on the separability of the facets raises questions as to whether there are separable developmental paths to these facets. For example, guilt and conscience can be assessed in very young children with some laboratory paradigms extending down to toddlers (Kochanska & Aksan, 2006). However, even in children this young, these traits are a complex meld of fearful temperament and "effortful control" (persistence) as well as parental style. Although there are overlaps between morality, conscience and achievement motivation, the latter reflects ongoing development through adolescence where parental values and children's identification with those values play an increasingly

central role (Eccles & Wigfield, 2002; Jodl, Michael, Malanchuk, Eccles, & Sameroff, 2001)

Behavioral measures. Additional clarity in this domain is likely to be achieved through more precise, behavioral measures of individual differences in reaction patterns and transactions with the environment. While behavioral measures of conscientiousness have been developed for very young children, comparable strategies have not been pursued for adolescents or adults. More precise measures of personality have been profitably developed in other domains such as rejection sensitivity, risk taking, and distress tolerance; these developments hold real promise of a better understanding of mechanisms underlying differences in these dimensions (Bornovalova, Fishman, Strong, Kruglanski, & Lejuez, 2008; Daughters et al., 2005; Gratz, Bornovalova, Delany-Brumsey, Nick, & Lejuez, 2007; Hopko et al., 2006; Lejuez et al., 2007). Among the many advantages of this level of behavioral measurement is that it reflects behaviors of specifiable onset, duration, and intensity, which are key ingredients for investigating neural processes that underlie the distinctive social cognitions, affective reactions, and behavioral responses that make up personality "dispositions" (Fein & Chang, 2008; Harmon-Jones, Peterson, & Harris, 2009). In many cases behavioral measures have reframed questions about personality. Descriptive analyses—such as the NEO—ask "what is the personality of an individual or a group." Behavioral measures take a more functional approach: "how does personality function to shape patterns of behavior?" We turn to this question in the next section.

Functional versus Descriptive Conceptualizations of Personality.

Understanding personality function as a set of self regulatory mechanisms offers an alternative window on how personality and health are linked. This conception is consistent with Freud's dynamic view, which conceived of personality as an effortful development of a set of mechanisms for regulating drives. These have been termed "defenses." In more recent psychoanalytic thinking the concept of drives has been less central; defenses are considered typical or consistent ways in which individuals handle painful circumstances, whether of internal (memories, desires) or interpersonal origin. There have been several notable efforts to measure defenses and to understand the distinction between more mature and adaptive defenses versus those that are more likely to lead to poor adaption. This approach to personality assessment has produced impressive long term predictions of psychological health at mid-life and later (Vaillant & Mukamal, 2001).

The psychoanalytic approach to personality assessment is example of a broader class of *functional approaches* to personality. Personality features are understood less as descriptors of dispositions, and more as psychobiological mechanisms best defined in terms of their consequences for adaptive cognition, affect and behavior.

Earlier conceptions of the regulatory functions of personality bear important similarity to contemporary conceptions of emotion and self regulatory processes; these have been extensively studied in early development and young adulthood, and are now becoming a

focus in aging research. The origins of these regulatory functions in infancy and childhood have been pursued (Bradley & Corwyn, 2008; M.K. Rothbart & Bates, 1998; M. K. Rothbart, Posner, & Hershey, 1995; Mischel, Shoda & Rodriguez, 1989). Here, sophisticated behavioral observation techniques and psychobiological tools have combined to delineate individual differences among very young children that have successfully predicted their developmental trajectories through early adulthood. To date, this approach has not been extended to understanding the mechanisms underlying individual differences in personality features such as conscientiousness in mid-life and aging. A better understanding of self regulation (and its various modes or facets) may lead to improved understanding of the links between personality and health by a) offering a more detailed, mechanistic perspective on how personality manifests itself in patterns of cognition, affect and behavior b) shedding light on how these self regulatory functions select individuals into protective or risky social environments, and/or c) enhancing knowledge of links between personality and neural, hormonal, cardiovascular, immune and other regulatory mechanisms linked more directly to health outcomes.

Considering these dynamic features of personality raises a critical issue: does a "dispositional" theory of personality—as reflected in the NEO system—allow an adequate range of research on the role of personality in healthy aging? More important, does it provide an adequate base for the translation of personality research into practical interventions or policy? Notably lacking from the dispositional approach are concepts of motivation, conscious or otherwise; individual and cultural values; and reflective functioning, i.e., the capacity of individuals to recognize and understand components of their own personality and that of others (Bouchard et al., 2008). Of particular interest is the extent to which personality reflects internalized experience of key caretaking relationships and the developmental of social schemata that serve as nuclei for coping in circumstances of severe interpersonal stress. In this domain, improved measures of attachment and attachment style have proved useful in explaining stability and individual variation in coping strategies and patterns of social behavior though they are infrequently applied to problems of aging. (Crawford et al., 2007; Fonagy & Target, 2005; Main & Goldwyn, in press; Shaver, Lavy, Saron, & Mikulincer, 2007). On a larger scale, certain personality traits may result from social or economic reinforcement of particular dispositions in ways that may vary with historic period, cohort, nation, socioeconomic status, gender, etc. (See, for example, Bowles, Gintis & Osborne, 2001).

Contemporary research on emotion, motivation and aging offers yet another dynamic perspective for personality theory in aging. Carstensen and her colleagues have proposed that as people age, awareness of the limited time left in life orients motivation toward emotionally meaningful goals. This, in turn, is posited to lead to enhanced self-regulation in the service of these goals (Carstensen, 2006). These claims are supported by accumulating evidence of changes in emotional information processing and in social problem solving that seem to support the maintenance of emotional equilibrium and the reduction of internal and interpersonal conflict (Carstensen, 2006; Blanchard-Fields, Mienaltowski, & Seay, 2007). Emerging research in affective neuroscience of aging supports the view that in healthy older adults, neural processes supporting emotion regulation are maintained, while the processing of negative information may be altered in

some circumstances, possibly related to goals to avoid negative or conflictual states or information (Mather et al., 2004; Urry et al., 2006; Samanez-Larkin, et al., 2007, St. Jacques, et al., 2008). Whether these findings are due to motivational changes or to structural and/or functional changes in the brains of older individuals remains to be determined. In the domain of cognitive aging, Denise Park (Park & Reuter-Lorenz, 2009) has argued that specifiable compensatory mechanisms—originating in the frontal lobes—offset the deterioration of a broad range of cortical and sub cortical structures. The notion that aging involves the *development of new structure and functions* to maintain homeostasis of function may apply in personality theory as well. Hiding under the guise of substantial *continuity* in personality function across aging may in fact be new methods of self regulation and adaptation—as yet unidentified—which allow, for example, consistency in many of the sub functions implied by the construct of conscientiousness.

Pathways Linking Personality and Health.

A third domain of study is an understanding of *mechanisms linking individual differences in personality to long-term psychological adjustment and physical health*. The causal inter-connections between personality, health, and longevity are complex, with numerous pathways proposed in the literature. Personality dispositions may incline people to specific health behaviors, or to select environments in which certain diseases are more likely to emerge. Alternatively, personality may alter physiological processes (such as stress reactivity) in ways that predispose to disease, or health and personality may be linked through a third causal (possibly genetic) factor. Finally, personality may be a result of, rather than a predictor, of health status. Unpacking these interconnections may require a life-span epidemiological personality approach (Friedman, 2008). In support of the health behavior model of personality – disease associations, conscientiousness has been positively linked to a range of beneficial health behaviors, and negatively to risky health behaviors (See Bogg & Roberts, 2004, for a recent meta-analysis). To further unpack these connections, the following pathways merit deeper exploration:

1) Personality features, particularly those that appear early in life, may represent the earliest manifestations—in the developing individual—of underlying genetic or other biological mechanisms. In this perspective, personality is *anticipatory* but not causal.

2) Personality may play a decisive role in *social selection*. Personality and behavioral characteristics can play a role in how individuals are selected into (or how they actively enter) social environments and how long they are retained (or actively remain) in these environments. These selection effects can start individuals on trajectories that can have long lasting and cumulative influences on a broad range of behavioral, social, economic and health outcomes.

3) Components of *personality may, much more directly, shape a cascade of adaptive (or maladaptive) social cognitions, affective reactions, and behavioral responses* that mediate the causal influences of personality on adjustment and health.

4) Personality or personality change later in life may be *a consequence of health status or change in physical health* and represent a signature of, for example, vitality, disease, or terminal decline.

Malleability and Reversibility of Personality Features.

We need a fuller understanding of the *malleability or reversibility* of maladaptive personality features, in this case low conscientiousness. For example, since high conscientiousness seems to be related to a range of positive health outcomes, the benefits of enhancing it in those who are low could be substantial even if the effects of interventions were modest. In this domain, as well as in others, unpacking the construct may enable us to make better use of existing prevention and clinical trials and plan better ones. For example, if we focus on the achievement striving or motivation components of conscientiousness, there may be much to learn from interventions at a much earlier age, particularly school-based interventions that have produced sustained changes in achievement motivation (Wigfield & Wentzel, 2007). Also, there are preliminary data that interventions can successfully improve self-efficacy (Hyde, Hankins, Deale, & Marteau, 2008; Luszczynska & Tryburcy, 2008; McNatt & Judge, 2008). Functional approaches to personality also have led to promising and cost effective interventions (Brown et al., 2008).

Informing these studies are investigations of *natural change in personality*; conscientiousness shows as much change as any personality feature across the life span. Specific life and occupational experiences may play a role (Roberts & Mroczek, 2008). Closely related are studies of the *maturation* of personality (Klimstra, Hale, Raaijmakers, Branje, & Meeus, 2009; Lodi-Smith, Geise, Roberts, & Robins, 2009; Sturaro, Denissen, van Aken, & Asendorpf, 2008) and the changes in personality in response to major life transitions such as having children (Jokela, Kivimaki, Elovainio, & Keltikangas-Jarvinen, 2009) or in response to environmental adversity such as impoverished neighborhoods (Hart, Atkins, & Matsuba, 2008). Major events such as war and combat exposure have been studied for both their positive and negative impact on personality (Solomon, Dekel, & Mikulincer, 2008). Here again, historic period, culture, and social class may have an impact on which personality traits are more likely to emerge in an individual or social group.

Finally, contemporary psychotherapy research is making major inroads in understanding and changing long-standing personality patterns. Two major streams of research (with overlaps between them) have shown notable success. Both derive major strength from detailed analyses of the functional aspects of exaggerated personality features. One stream focuses carefully on behavioral and cognitive analyses of personality, particularly the function—however maladaptive—of extreme behaviors and thoughts. The exemplar approach is Dialectical Behavioral Therapy and substantial data attests to its effectiveness (Linehan et al., 2006; Lynch, Trost, Salsman, & Linehan, 2007) in moderating impulsivity, emotional lability and interpersonal dysfunction. A second stream of work draws on psychoanalytic approaches to analyzing the functional aspects of perceptions of self and others that show dysfunctional extremes in disorders of personality. Interventions

show improvements in self regulation and interpersonal adaptation that have lasted as long as 8 years (Bateman & Fonagy, 2008; Clarkin, Levy, Lenzenweger, & Kernberg, 2007).

Role of Genetics in Understanding Personality.

Running through many of these issues is the *novel use of genetics*. As noted, multivariate quantitative genetic analyses of twin and sibling data can help in identifying components of conscientiousness that are likely to be more homogeneous with respect to both genetic and environmental influences. Genetic analyses can also be helpful in understanding the mechanisms that link conscientiousness to late life outcomes by exploring selection effects and by estimating the role of genes common to both earlier personality predictors and later health and behavioral outcomes. Little understood is what impact selection effects have on education and socialization, factors which may impact the development of personality dispositions through social reinforcements and skill learning. Molecular genetics and epigenetic studies will play an increasing role in understanding the neuroregulatory mechanisms indexed by conscientiousness scores. Finally, quantitative, longitudinal genetic designs—using twin and adoption studies--will help weight classes of theories that attempt to account for time-to-time change in personality. For example, several quantitative studies suggest that stability in personality is maintained largely by the *stability of genetic* influences across broad spans of adult development (Viken, Rose, Kaprio, & Koskenvuo, 1994) whereas changes in genetic expression during adolescence account for considerable instability in personality during this period (Gillespie, Evans, Wright, & Martin, 2004; Reiss, Neiderhiser, Hetherington, & Plomin, 2000).

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Topics to be addressed in the Conscientiousness and Health Aging Workshop

Overarching Questions

- In general, we are interested in understanding where the gaps are in research on health and personality, broadly, and conscientiousness, more narrowly, and what opportunities there are for furthering our understanding in this area. We are also interested in gaining a better understanding of what research might be needed to inform intervention and prevention efforts focusing on personality characteristics. Questions on more specific topics are below.

Conceptualization and Measurement of Conscientiousness

- Are there other ways of measuring conscientiousness or related concepts that might yield more clarity on the mechanisms by which it is linked to health outcomes in aging?

- How might alternative conceptualization of personality, those drawn from psychodynamic and motivational theories as well as work on attachment and behavioral approaches, be helpful in exploring new or supplemental measurement approaches in this area?

Functional versus Descriptive Conceptualizations of Personality

- Do current conceptions of conscientiousness allow for an adequate range of research on the role of personality in healthy aging? Would it be beneficial to consider personality in more dynamic terms, perhaps as a set of self regulatory mechanisms?

- Would it be beneficial to include concepts of motivation, and of individual and cultural values in our thinking about personality?

Malleability and Reversibility of Personality

- What models are available for addressing the malleability of key features of personality? Can we draw lessons from the impact of major historical or personal events on personality, from psychotherapy, from animal studies, from neurobiology or from larger scale social experiments drawn from economics and policy research?

Role of Genetics in Personality and Aging

- Can we outline a program of research that combines or integrates quantitative and molecular approaches to refine the broad contructs of personality and to improve our

understanding of its links to healthy aging? Can genetics help us understand the problem of malleability?

Pathways Linking Conscientiousness and Health

- After considering the previous questions, do you have thoughts on innovative areas of research that would better help understand the links between conscientiousness and positive aging? How might the integration of genetics, biomarkers, and behavioral measures best play a role in this new research?

John Clarkin, Cornell Medical College

The goal of this project as described is twofold: 1) identify predictors of social, cognitive, and physical outcomes in late life, (it is apparently presumed that personality and traits are the major predictors) and 2) use the predictors to identify and intervene with high-risk groups. This reviewer thinks that: 1) it is premature to focus on the trait of Conscientiousness as the major or sole predictor, as there are probably combinations of traits that can better explain the variance in outcome, and 2) the focus on a psychological trait assessed by paper and pencil tests should be compared to other methods of assessment (e.g., interview).

Conceptualization and Measurement of Conscientiousness

Traits are abstract statements of behavioral inclinations derived from factor analysis of self-report instruments. The traits do not reside in individuals. The traits are global descriptions of dispositions that correlate across individuals.

The concept of conscientiousness and related issues may be quite useful in identifying internal attitudes that may drive health behaviors. However, the manner in which the concept is operationalized is another matter. I would favor the concept, but give a great deal of thought to how the concept is measured, and would not place all my effort in this regard in the use of the NEO-PI. The NEO-PI has some limitations that should be noted:

- There is serious debate about the inability of the NEO-PI to pick up personality pathology. While some concepts relevant to clinical pathology are included, such as neuroticism, many think that the instrument is limited in its coverage of pathological issues.
- The NEO-PI given to an individual captures the general dispositions of the individual to the extent that the individual is self-aware and can accurately report on self. Asking about behaviors may be more beneficial than asking about general dispositions.
- The impact of the environment is not adequately captured in the NEO-PI. This issue is evident in the work of Roberts et al. (2009), who tried to overcome this difficulty be obtaining trait measures from the spouse as well as the married subject.
- Paper and pencil self-report measures have the advantage of requiring less effort from the investigator, but may be most useful as screening devices rather than the major measurement of key variables.

It is not clear why one would launch a large study of healthy aging, and depend upon only one trait, i.e., conscientiousness, as the sole predictor personality variable. I have noticed in some of the studies that the researchers utilized a combination of conscientiousness with trait neuroticism from the NEO-PI as predictors of healthy aging (Roberts et al., 2009). This combination of conscientiousness combined with negative affect seems more advantageous in predicting healthy aging in a population that varies in terms of degree of mental health. I assume that future studies would want to identify healthy aging and its absence not only in those relatively normal, non-clinical individuals but also in that part of the population that suffers from various mental disorders. It would

seem that Axis I disorders such as depression, and Axis II disorders of personality would related to healthy aging.

One cannot assume that the trait name assigned to the group of correlated items is an accurate description of the trait, which is often multi-faceted.

Rationale for the Selection of Conscientiousness as the Predictor

It is interesting and informative to not only examine existing research on the association of conscientiousness and healthy aging, but also the rationale for the selection of the particular trait. (So, how was conscientiousness identified among the various traits as a predictor of healthy aging?)

A growing body of research has accumulated to show the predictive power of conscientiousness to health outcomes.

The trait of conscientiousness can be conceptualized as a mediator between life style, availability of health care and the utilization of health care services in a preventive way. (However, life style is possibly shaped by conscientiousness.)

Functional versus Descriptive Conceptualizations of Personality: Limitations of a Trait Approach

Individual behavior is generally conceived as an interaction between individual personality and related dispositions, and the environment. What are unique to the individual are both the internal cognitive-affective units and the environments in which the individual tends to place him/herself (Mischel & Shoda, 2008). From this interactional point of view, trait measurement is lacking. It is difficult to predict behavior based entirely on traits or dispositions, without some measurement or understanding of the individual's environment. It is obvious, of course, from the current national debate on health care reform that many conscientious individuals cannot afford health care.

As noted in the preparatory paper by Reiss et al., it is doubtful if traits measured as general dispositions cannot provide an adequate base for either understanding the links between personality dispositions, actual behaviors, and their interaction with the environment that lead to life style issues and seeking of health care in a way that leads to optimal aging and health.

Pathways Linking Conscientiousness and Health

One might sharpen the discussion about predictor variables if there is a clear focus on the different dependent variables. The distinction has been made between health behaviors and health outcomes (Hagger-Johnson et al, 2007). One could predict outcome, i.e, the individual's actual health, life style, and life satisfaction; or, one could concentrate on the health behaviors that the individual could use to maximize health outcomes, such as no smoking, drinking in moderation, regular check-ups, social relations, etc. The former must be related to genetic issues not under the control of the individual, whereas the latter is closely related to the individual's behavior and personality. It would seem in this regard that intervention studies would produce more clear results if the latter approach was utilized.

In this regard, a sampling of previous research using conscientiousness and other personality variables as the predictor variable, the following outcomes have been targeted:

- Duberstein and colleagues (Chapman, Duberstein, Sorensen, & Lyness, 2006; Duberstein, Sorensen, Lyness, King, Conwell, Siedlitz, & Caine, 2003) used perceived health and functional status as the outcome variables, with personality as the predictor variable.
- Hagger-Johnson and Witeman (2007) used health behaviors (wellness-behaviors, accident control, and traffic risk) as the outcome variable.
- Roberts, Smith, Jackson, & Edmonds (2009) utilized subjective sense of health and physical functioning (mobility, instrumental activities of daily living, etc.) as outcome variables.

It is possible that trait variables, such as conscientiousness, may have differential relationships to subjective sense of health, physical functioning, and health related behaviors. Subjective view of health and life satisfaction might be predicted by personality variables, as these overlap with satisfaction, positive affect, etc. In contrast, actual health functional status may depend upon genetic issues, health—ill health issues not directly related to life style, as well as personality issues which may relate to health behaviors (regular check-ups, exercise, etc.).

Malleability and Reversibility of Personality

Reviews suggest that both normal personality and personality disorders manifest features of both stability and change.

In terms of possible interventions for those at risk and late life health outcomes, it is interesting to note that clinicians in the mental health field are not interested in the measurement or use of traits to target their psychotherapeutic interventions. Rather, mental health clinicians are interested in patient narratives about their interactions with the environment.

In order to increase late life health outcomes, the intervention would not focus, one could argue, on the trait of conscientiousness, but rather on behavioral aspects of life style, monitoring of health care issues, and utilization of health care services.

Role of Genetics in Personality and Aging

Research by Livesley (Livesley, Jang, Vernon, 1998) and others would suggest that about 50% of variance in personality traits is hereditary. The role of genetics in various diseases and the aging process must be major. Given the focus of this teleconference on the trait of conscientiousness with the lack of a fully developed model of the links between a trait like conscientiousness and the healthy outcomes, I would think this work should be done before introducing genetic research.

Research on Personality Pathology and Health

Our research group has not studied healthy aging, but in a sense, has studied personality pathology that is directly related self-destructive behavior which could lead to poor health and unhealthy aging. The contrast may be informative. For example, we have studied:

1. The NEO-PI constructs in borderline patients. The focus of this research was to characterize carefully diagnosed borderline patients (by structured interview) with the NEO-PI constructs (Clarkin, Hull, Cantor, & Sanderson, 1993). This work is in some ways related to the current topic, as borderline

patients are self-destructive in many ways besides being actively suicidal at other times. In general, these patients were characterized by very high Neuroticism and low Agreeableness scores, while Conscientiousness was variable within the group. This would suggest that just a focus on Conscientiousness would not capture the unhealthy life styles of these patients, admittedly an extreme group. We did not feel that the NEO-PI constructs captured adequately the range of pathology in this population. The instrument seems more suited for a relatively healthy population. This would suggest that if you are trying to predict healthy—unhealthy aging across the entire population, one would not depend totally on items or constructs from the NEO-PI.

2. Risky sexual practices in borderline patients and their trait correlates. A large group of hospitalized women with the diagnosis of Borderline Personality Disorder were interviewed at length about risky sexual practices (Hull, Clarkin, & Yeomans, 1993). It was hypothesized that those with the BPD diagnosis, including the criterion of risky sexual behavior, might be in danger of HIV infection. As hypothesized, it was found that roughly half of the sample engaged in risky sexual behaviors. The other half of the sample was avoidant of intimate and sexual relations. Most interesting, the part of the sample that engaged in risky sexual behaviors were more healthy on normal personality traits, such as warmth and need for interpersonal relations than were the group that avoided intimate relations. We did not focus on the trait of conscientiousness as such, but the study does suggest that behaviors risky to health (i.e., risky sexual behaviors) are not always predicted by traits.
3. Self-destructive behaviors, including outright suicidal behavior, but also more subtle forms of self-destruction including ignoring health issues.

Recommendations/Conclusions

1. A personality trait approach to predicting healthy late life adjustment should be enhanced by more functional, intermediary measures of behaviors and environmental factors leading to the desired outcome.
2. The trait of conscientiousness has attracted interest and some accumulated data relating to healthy late life outcomes. This role of conscientiousness should be utilized. One productive way to use this trait would be as a moderator variable in intervention research. Thus, individuals at various levels of conscientiousness (high, low, very low) could be randomized to different interventions.
3. Psychotherapy research even that targeted to the personality disorders has not approached the issue of modifying or changing personality per se. Rather, these studies have been focused on modifying symptoms and symptomatic behaviors in those diagnosed with personality disorder, using the Axis II criteria, not diagnosed with trait instruments. Given this state of the art, the idea of intervening to modify a trait of conscientiousness seems premature and raises a number of issues (e.g., the stability of measurement of traits; the relationship of a general trait of conscientiousness versus conscientiousness around health and life style issues, etc).

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Angela Duckworth, University of Pennsylvania

Given evidence that traits in the Conscientiousness family predict long-term health outcomes[1], where should research go next? I offer below my thoughts on the topic, with the caveat that the majority of my research to date has focused children and adolescents. My perspective is also circumscribed, to a degree, by my interest in one Conscientiousness trait in particular: self-control, defined as the regulation of behavior, attention, and emotion in the service of personally held goals and standards.

I could not agree more that the conceptualization of Conscientiousness needs clarifying. Not much progress can be made when there is so much inconsistency among researchers about what the major Conscientiousness facets are and should be named. How else can results across studies and laboratories be compared and synthesized? Such consensus has not been possible for even one particularly well-studied facet of Conscientiousness: self-control. There is, of course, the jingle problem: multiple terms for a common (or largely similar) construct. An incomplete list of synonyms for self-control includes: effortful control, ego strength, ego resilience, willpower, self-regulation, self-discipline, time preference, delay of gratification, executive function, inhibitory control. Attention deficit/hyperactivity disorder (ADHD) may also be essentially another term for (lack of) self-control. A cursory review of the symptom checklist suggests this to be the case – as does a recent meta-analysis I completed showing convergent validity for ADHD and self-control measures.

Even more problematic, diversity in how self-control is conceptualized has led to diversity in how the construct is measured. Neuroscientists and cognitive psychologists tend to operationalize self-control as performance on executive function tasks (e.g., Stroop task, go/no-go task) and personality psychologists tend to give self-report or informant report questionnaires (e.g., Barratt Impulsiveness Scale). Hypothetical or behavioral measures of delay of gratification constitute a third category. In a recently completed meta-analysis of studies that used more than one measure of self-control, I found that the intercorrelations among these diverse measures of self-control average r = .23, precisely the same magnitude as the association between measures of self-control and intelligence.

What's going on? Likely, various factors (e.g., error variance, task specific variance) erode correlations among self-control measures. Perhaps the most interesting of these causes is the multidimensionality of the construct. Different processes might be involved in regulating anger during an argument with one's husband as are involved in resisting the office donuts in order to stick to one's diet. Still other processes might be involved in sustaining focused attention and resisting distractions. This does not preclude the possibility of shared processes (e.g., working memory), of course. Thus, there is some justification in being a "lumper" who studies self-control at a higher level of abstraction (or, indeed, Conscientiousness at a still higher level). Still, my intuition is that our

[1] I should also note that more work, obviously, is needed to fully elaborate the predictive relationships – which facets predict which outcomes, where do we have strong evidence for causality, etc. In my own work, I find self-control protects against weight gain, controlling for IQ, SES, maternal weight, gender, and a variety of other factors. But, like most conventional longitudinal research, I cannot rule out the possibility of an unmeasured third-variable confound.

understanding of what self-control really is and how we can change it will come from "splitting" self-control into its component processes and studying how they work independently and in interaction with others.

One concrete suggestion, therefore, is to study facets of facets of Conscientiousness across the lifespan. One might find that divergent trajectories from birth to death help separate these processes. Such an effort would entail giving a large battery of self-control to individuals at various stages of the life cycle - and then analyzing the data cross-sectionally. While maturation and cohort effects would be impossible to disentangle, divergent trajectories would nevertheless provide evidence of independent components of self-control. The same data could be factor analyzed, using evidence of convergent, discriminant, and predictive validity (for a variety of theoretically relevant outcomes including specific aspects of health) to determine these components. Evidence from functional neuroscience could also contribute to the question.

What I think we will find, if we have the patience and resources to complete such studies, is that there is even *more* splitting to do. In particular, I think we will find domain specificity even once a component process has been isolated: individuals who exercise admirable self-control over their temper at work, for instance, may not necessarily do so with their spouses. I have found that there is more than six times more variance in self-control within individuals across domains (e.g., work tasks, finance, interpersonal relations, food, exercise). Perhaps a substantial portion of domain-specific variance derives from differences in processes (emotion regulation vs. regulation of attention, as I alluded to above). But my guess is that another source of within-individual variance across domains has to do with motivation, discriminant cues and habits. The implications for health are straightforward – to the degree that personality is context-specific, interventions to change health-relevant self-control must also be.

This brings me to arguably the most compelling question psychologists can ask about Conscientiousness and health: What can be done in terms of deliberate intervention? Apart from generalizeable lessons from psychotherapy, not much is known about how to intentionally cultivate self-control competence in adults. We have, however, learned a lot about its development in children. Perhaps the most profound lesson is that, notwithstanding heritable factors, self-control is dramatically facilitated by learnable, teachable, metacognitive strategies. For example, staring at the marshmallow in the preschool delay of gratification paradigm undermines efforts to resist it. Covering or looking away from the marshmallow, in contrast, greatly increases voluntary wait time in the same situation. Adults, conceivably, could be taught to use their attention strategically: Putting unhealthy food out of sight, for an individual of any age, should help curb desires to consume it. Putting running shoes where one must practically trip over them everyday should make it hard to "forget" to go jogging.

The strategy of planning is also simple yet surprisingly effective. Creating an *if-then* plan in advance helps children resist distractions during a work task (If this toy makes noises and flashes lights, I will say, "I have to do my work now!"). In adults, the same if-then planning strategies has been taught to adults trying to improve their physical health through exercise and healthy eating (i.e., If it is Wednesday at 6pm, I will go to the gym!; If the waiter hands me the dessert menu, I will say right away that I will only have coffee.).

Changing, deliberately, how we mentally represent temptations can also help. Young children who pretend the marshmallow is a fluffy, white cloud (rather than a sticky, gooey sweet treat) can wait twice as long as those not prompted to perform such a cognitive transformation. I have taught this "psychological distancing" technique to adolescents and found measurable effects on anger and sadness regulation (though these effects have not lasted beyond the testing session). I am guessing the same strategy might help dieters passing billboards with the latest McDonald's creation in full Technicolor.

There is evidence that pretend play with other children is an important vehicle for the development of self-control (because it demands – and rewards regulation of behavior, emotion, and attention). In laboratory studies, children who take on a pretend role (e.g., to be a guard on a castle wall) can do what they seem otherwise not able to do (e.g., wait silently for a long time rather than play with a coveted toy). I'm wondering, could adults use the same strategy? What would happen if adults struggling to quit smoking vividly pictured a person they knew well who did not smoke and then *pretended* to be him or her? Could they realize some benefits in self-control that, if rewarded, would be sustained? Can you fake it till you make it? It's a far-fetched idea, I realize, but one I would love to pursue.

In closing, I suggest that interdisciplinary work uniting psychologists of various stripes with other kinds of scientists (e.g., economists, sociologists, neurologists) might be the most promising way forward. But, such research collaborations are fraught with unique challenges and hurdles – as if academia didn't have enough of these, particularly for the junior academics. I'm guessing that the scientists who engage in this kind of work – and the funding agencies that support it – will need to exercise a great deal self-control to persist at it.

Jacquelynne S Eccles, University of Michigan

Conscientiousness, personality, beliefs and values: Assets for Healthy Aging?

I am going to address the issues raised in the November 10th memo from the perspective of a life span motivational psychologist interested in relatively stable individual differences. My own work has focused extensively on:

- The role that expectancies (personal efficacies), subjective task values, and both personal and social identities play in explaining individual differences in task/activity choices across a wide range of behaviors during the 2nd two decades of life.

- The ways in which both concurrent and previous social experiences and social contexts feed into these individual level processes, as well as the ways in which life course-related changes in social context/social experience help to precipitate changes across time in the psychological processes underlying task/activity choices as well as more general well-being.

- I am particularly interested in how motivational beliefs linked to identities, as well explanatory systems, shape longer term social pathways that can effect
    - long term exposure to social and physical contexts and stressors
    - life styles in ways that impact on long term health, resilience, and well-being.

Although I have not directly studied aging populations, I believe the theoretical models I use to understand behavioral choices and developmental changes in well-being during the second two decades of life are appropriate for studying such changes later in life as well.

Although I wouldn't have classified my work as directly related to the Big 5, my research interests are closely linked to the following aspects of conscientiousness: competence and self efficacy, achievement strivings, dutifulness and fulfilling obligations, and deliberation. My general orientation focuses more on the functional aspects of personality (or what I would call relatively stable and enduring personal characteristics and values) than on the descriptive conceptualizations of personality. I am particularly interested in how relatively enduring beliefs/self-schema related to one's competences across various activity domains coupled with the value one attaches to being competent (or engaged) in these various activities influence behavioral choices and longer term identity formation, which in turn influences selecting and being channeled into specific life style pathways (pathways that vary along physical and social dimensions in ways that are related to health and well-being). I am also interested in how temperamental, aptitudinal and other stable characteristics commonly thought of as personality characteristics relate to these developmental processes. With regard to life span development, I am particularly interested in the processes associated what Paul Baltes and colleagues labeled the SOC model – selection, optimization, and compensation (see Freund & Baltes, 1998). With regard to conscientiousness, I would

predict that conscientious individuals with adaptive coping skills and positive general well-being will engage in adaptive forms of SOC throughout their life spans. Finally, because I am an educational psychologist, I am very interested in the ways in which designed interventions can change the life course trajectories for people on risky pathways – or can change maladaptive personal cognitive-emotional-behavioral systems into more adaptive personal systems. My comments in this memo grow out of these fundamental orientations.

Within my theoretical perspective, I am interested the ways in which such characteristics such as effortful control, interest in novelty, persistence, desire for challenge, deliberation, and desire to do one's best are linked to the behavioral manifestations of both expectations for success and subjective task values over time. Within the Eccles expectancy – value model, we predict that behavioral enactments of various goals depend on the expectations one has for success and the value one attaches to achieving the goal. We define subjective task value in terms of four components: interest value (how much one likes doing the task), utility value (how useful is the task for other goals), attainment value (how well does engaging in the task confirm one's own identity –core personal traits or goals - to one's self or others), and cost (how much does engaging in the activity distracts from other valued activities) (Eccles, 1994; Wigfield et al., 2006). If we want to understand behavioral choices (such as adherence to a healthy life style, adherence to medical regimes), then we need to understand both the cognitive motivational forces that underlie these choices and the temperamental and emotional characteristics that either support or undermine each individual's ability to implement their goals or fulfill their identities while they are also dealing with all of the other challenges of life and aging. That is, we would predict that personality characteristics like conscientiousness will influence behaviors only to the extent that those behaviors are highly valued and the individual has a reasonable chance of succeeding at the goal. So we need to create profiles of individuals based on their expectancies for success (domain specific self efficacies), their subjective task values for the range of activities competing for engagement, their "conscientiousness", their desire to explore their context (which is related to their attachment style), and their ability to effectively **Select** appropriate tasks that **Optimize** their likelihood of success with appropriate levels of **Compensation** for their cognitive, emotional, and physical skills. To the extent that a person does not have the optimal profiles, we then need to develop interventions that are designed to facilitate shifts in those characteristics in which they are "deficient".

In our model, we theorize about a variety of social and psychological influences on the ontogeny of individuals' expectations for success and subjective task value over the course of individuals' life times. These influences include temperamental and personality-like characteristics as direct effects, as well as the moderating type effects discussed in the previous paragraph (Eccles & Wigfield, 2002; Eccles & Alfeld, 2007; Wigfield et al., 2006).

I also believe that the concepts of personal and social identities are critical. I assume that these identities have motivational power because they influence the subjective task value of various activities to the individual – making some activities much more attractive than others because these activities confirm individuals' views of their ideal and real selves. We need much better measurement of the content of these identities and we need studies that link these identities with the characteristics of conscientiousness

to determine if the enactments of one's identities are influenced by one's "conscientiousness" in combination with other psychological assets and risks (Eccles, 2009).

Then we need research on how these identities are shaped and changed over the life course, as well as how the salience of individual's social and personal identities are influenced by the social contexts one is in over both the short and longer run. I assume identity formation is a lifelong task. I also think that life course-related changes such as retirement, death of a spouse or close friend or relative, or declining physical or mental capacity can influence both identity formation and identity change in both positive and negative ways. Losing a well-established and cherished personal or social identity (such as by forced retirement or death of a loved one) can be devastating because these identities are so core to the person's "self". Coping with such a loss involves a variety of other skills and enduring personal characteristics. Conscientiousness seems likely to be particularly important in several ways. For example, a conscientious person (if we mean deliberative) may have already thought about the likelihood of such sudden self-threatening losses and worked on a plan, which might involve having created new identities. To implement such a strategy, the conscientious individual needs to have sufficient knowledge about likely life changes and alternatively coping options to make wise Select, Optimize, and Compensation (SOC) decisions. Being a member of supportive and knowledgeable social group or cultural niche would also be helpful. Baltes and colleagues argued that our cultural has not caught up with the nature of changing life situations among the aging to make sure that individuals are provided with the appropriate cultural and social supports to enable effective SOC for aging individuals (see Freund & Baltes, 1998). Conscientious individuals may be better able to seek out such support and scaffolding but even conscientious individuals need some support. Alternatively, a conscientious person might be more likely to seek out help after such a crisis has occurred and then conscientiously tried to implement recommended strategies. Again the ability of conscientious individuals to engage in this type of help seeking depends on its availability. This same line of reasoning can be applied to a wide range of likely changes people experience as they age.

Conscientious individuals may be more likely to have made better behavioral choices earlier in life about the kinds of life styles likely to support optimal aging. Depending on their aptitudes and "personality", they may have included healthy longevity in the subjective task value they attached to various careers, avocations, marital partners, life style, and recreational choices (like number 2 of page 5 but I am focused on choosing social environments rather than being selected into). If so, then given a choice between a more or less stressful career (or marriage or hobby) in the area one wants to pursue, a conscientious individual might pick the less stressful option or might be careful to include stress reducing recreational activities to compensate for the stress they experience in the work place.

But to understand how a characteristic like conscientiousness would play out in an individual's choices, one would need to know why they are making various choices. I believe we can predict that a conscientious person has greater likelihood of implementing their choices but knowing how conscientious they are won't necessarily let us predict what their goals will be. Addressing this type of question requires integrating research on conscientiousness with research on life and task choices. Can one be conscientiously

reckless? Are great military fighter pilots conscientious? What about great athletes in sports that are likely to lead to physical injuries that will compromise one's physical comfort later in life? For example, would a conscientious person be more likely to take up a practice like mediation over extended periods of time as a way to reduce stress and maintain a healthier mind and body? Would a conscientious person be more likely than a nonconscientious person to take up such a practice if they were given the proper training and opportunities to learn such practices? Would a health-conscious person be more likely to seek out such training if they were also conscientious? Would a conscientious person (defined as dutiful and fulfilling obligations) be more likely to take such training if their spouse asked them to in order to increase the likelihood of their being able to spend their elderly years together?

As you can see, I have stressed the behavioral and functional aspects of personality and life choices and I have stressed the need to take a broader view of how various aspects of a person need to be studied in integrated ways. Although I have not focused on genetics or neurobiology, I certainly think these aspects of development can be incorporated in studying the various types of questions I suggest. I have also focused on how social contexts can interact with these person level processes and dynamics over the life course to create change or to induce additional stressors that require the individual to change. The impact of these social contextual changes will depend on both stable personality characteristics like conscientiousness, and the physical changes in the body and the brain due to aging and prior social and physical experiences. Longitudinal research (both short and long term) are needed to map out these various pathways and to determine the most effective interventions at various ages.

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Conscientiousness, Health, and Longevity

Historically, conscientiousness was mostly ignored in studies of personality and health. The psychophysiological disruption very apparent in an emotion or emotional trait like anger and hostility (choler), depressive moroseness (melancholy), repression and alexithymia (phlegmatic apathy), or the struggling competiveness of the Type A pattern attracted almost all the attention. So it was unexpected when we first discovered in 1993 that children who were conscientious and dependable, as rated by parents and teachers, were at markedly lower mortality risk, across seven decades (Friedman et al., 1993). In fact, conscientiousness --a tendency to be prudent, planful, persistent, disciplined, organized, and dependable-- is not highly related to the personality measures that were typically used in health psychology research (Booth-Kewley & Vickers, 1994; Friedman, Tucker, & Reise, 1995; Marshall et al., 1994). But, as is now known, it turns out to be highly relevant to pathways to health. Meta-analysis confirms that across 20 samples and over 8900 participants, conscientiousness is protective from mortality risk (Kern & Friedman, 2008). The predictive value of a conscientious, dependable personality on health and longevity appears as strong as or stronger than many widely recognized risk factors, including SES and IQ (Batty et al., 2009; Deary, Batty, Pattie, & Gale, 2008; Ozer & Benet-Martinez, 2006; Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007).

Simple explanations for this protective effect remain elusive, and the web of causal mechanisms exemplifies the complexity of the personality-health puzzle. Conscientious individuals are more likely to engage in health protective behaviors and to avoid risky behaviors, clearly supporting the behavioral model (Bogg & Roberts, 2004). The range of health-protective behaviors predicted by conscientiousness, and health-threatening behaviors predicted by unconscientiousness, is very impressive. Yet health behaviors alone do not explain the overall relationship (Friedman et al., 1995; Hampson et al., 2007; Martin et al., 2007; Weiss & Costa, 2005; Wilson et al., 2004).

Studies with animals, twins, and biological markers show links between conscientiousness-related traits and more stable biological function, suggesting basic biological pathways (Friedman, 2008; Figueredo et al., 2005; O'Cleirigh, Ironson, Weiss, & Costa, 2007; Williams, Kuhn et al., 2004). Serotonin is linked to conscientiousness, impulsiveness, and genetic variations of cortisol responses (Carver & Miller, 2006, Evans & Rothbart, 2007; Kusumi et al., 2002; Manuck et al., 1998; Wand et al., 2002). Just as increasing evidence reveals common biological predispositions to depression and cardiovascular disease-- thus explaining the failure of attempts to prevent heart disease by treating depression-- there may likely be biological third variables underlying some of the association between conscientiousness and longevity. This again implies caution in attempting any large-scale interventions to "treat" unconscientiousness.

In our work with the Terman Life Cycle study, both child and adult conscientiousness are associated with benefits across multiple domains of social integration (social support) and psychosocial stability. Conscientiousness predicts more successful careers, stable marriages, and better older age mental health. In addition, adult conscientiousness is protective even when childhood conscientiousness is controlled, further suggesting a key role for the adult social milieu (Martin & Friedman, 2000;

Martin, Friedman, & Schwartz, 2007). In addition to being valued employees and successful in general, conscientious individuals are more likely to have good social relationships, relationship stability, more community involvement, and academic success (Barrick & Mount, 1991; Bogg & Roberts, 2004; Gelissen & de Graaf, 2003; Kern & Friedman, 2008; Kern et al., 2009; Ozer & Benet-Martinez, 2006; Roberts et al., 2007; Schmidt & Hunter, 1992). The role of social relations in these overall links is only beginning to be understood.

To further complicate matters, it is often assumed, incorrectly, that most health-threatening life events (stressors) are unpredictable happenings or accidents. An important insight to emerge from modern psychology, however, is that personality can predict life events – also referred to as niche picking or situation selection. For example, neuroticism tends to foretell negative life events, and conscientiousness can foretell social integration. That is, it is often wrong to think of personality, located within the individual, as randomly encountering stressful or unstressful events (Bolger & Zuckerman, 1995; Magnus et al., 1993; McCartney, Harris, & Bernieri, 1990; Scarr & McCartney, 1984; Van Heck, 1997). A longitudinal analysis of personality and work experiences showed that personality at age 18 predicted both objective and subjective work experiences at age 26, and the traits that pushed individuals into specific work experiences were the traits that most changed in response to those work environments (Roberts, Caspi, & Moffitt, 2003).

A major mistake made in earlier research on personality and health was to study one trait and one disease at a time – such as the relationship between hostility and heart disease. (This mistake derives from the influence of the traditional biomedical model of disease.) Rather than studying personality and healthy aging trait by trait and disease by disease, it is conceptually and heuristically superior to start with a coordinated, unified paradigm. In such an approach, there is simultaneous attention to associations between multiple psychological traits and disturbances, and multiple diseases, impaired conditions, and risks of premature mortality. Such an approach maximizes construct validity and helps us avoid doing studies where, for example, cardiovascular mortality is examined but all-cause mortality is ignored. (There are many such seriously-flawed studies.)

A sensible research approach therefore is to assess basic dimensions of personality early in life, track developmental pathways, study health-relevant behaviors and social relations, and examine multiple health outcomes, including longevity and cause of death. Because this is rarely done, we are not yet near a suitably complex picture of individual differences (including conscientiousness) and health, one that is probably closer to the truth than simple cause-effect models. We need to understand more about why and how conscientious people generally have a predisposition to salutary reaction patterns; wind up with healthy coping styles, habits, and behaviors; and move towards and create social environments beneficial to good health (environments which, in turn, further influence behaviors, serotonergic activity, and subsequent environments). If personality is thought of as a traditional biological risk factor like hypertension or as a traditional social risk factor like education, then we are doomed to repeat the past failures in addressing individual differences in health and longevity.

Conclusion 1*: It would probably be a mistake at this point to focus intensively and directly on raising levels of individual conscientiousness in an effort to promote health. Some of the links between conscientiousness and health are non-causal, and many are indirect – involving social relations. Even in those cases of a relatively straightforward mediation via health behaviors, it might be more effective to focus directly on the healthy behaviors. However, promoting societal and cultural conditions that raise the likelihood of a conscientious and socially stable populace might potentially have dramatic health benefits.*

Conclusion 2*: Efforts to promote healthy aging are often aimed at adults at a single point in time, with little attention to the life-span trajectories along which the individuals are already traveling. Such models, which undervalue or ignore life trajectories, fail to consider the many different pathways to healthy or unhealthy patterns. For example, individuals are obese, or poorly nourished, or inactive for a variety of reasons in their life histories and are unlikely to benefit from exactly the same programs of change. This is also true for conscientiousness. A life pathways or life-course approach, with clusters of predictors and interactions between variables as moderators and mediators, seems especially promising at this stage, as we need to better understand the trajectories.*

Conclusion 3*: Personality is a powerful predictor of health and longevity because it captures biological inclinations, early socialization, and ongoing psychosocial experiences. Conscientiousness undoubtedly has a biological component, and serotonergic issues deserve continuing attention. Conscientiousness undoubtedly has a behavioral component and lifespan health behavior patterns need attention. However, one of the most pressing issues is understanding, in much more detail, the role of conscientiousness in selecting and maintaining healthy situations and healthy social relationships. That is, we need much more understanding of what conscientious and unconscientious individuals do and how they respond across long periods of time. Once this is better understood, it will be easier to imagine, develop, and test stronger interventions.*

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An association between conscientiousness and longevity is now well-established (Kern & Friedman, 2008), but the pathways that lead from conscientiousness to added years of life remain to be charted. To learn about these pathways, the research agenda is changing. Questions now being addressed concern how, not whether, personality traits influence health outcomes. This shift in direction calls for the creative study of the dynamic mechanisms of trait influence that develop over the lifespan. As suggested in the Background Statement, advances in this new direction may require different approaches to trait measurement and expanded theorizing about mechanisms of trait effects. This work offers the exciting possibility of interventions to redirect health-damaging life-course trajectories onto more healthful pathways.

Pathways from Personality to Health Outcomes

Some hypothetical pathways from low conscientiousness to mortality are mediated by morbidity (e.g., death from chronic illness), whereas others postulate risk taking (e.g., accidental death). Research on associations between low conscientiousness and morbidity is still relatively sparse, particularly prospective studies where morbidity is assessed by means other than self-report. Cross-sectional data from MIDUS demonstrated that conscientiousness was associated with reduced rates of numerous mental illnesses (assessed by diagnostic interview) and self-reported physical diseases, whereas neuroticism was associated with higher rates (Goodwin & Friedman, 2006). More objective assessment of disease, such as confirmed doctor's diagnosis or status on biomarkers, is important in this field where the tendency to report symptoms is itself an aspect of personality. A few studies of patient samples have associated higher levels of conscientiousness with slower disease progression (e.g., renal disease, Brickman et al., 1996; HIV, O'Cleirigh et al., 2007; Alzheimer's, see Background Statement); higher levels of impulsivity predicted onset of peptic ulcer disease over a two-year follow-up (Grano et al., 2006); and undercontrolled children had a greater risk of injury over a two-week period than overcontrolled or resilient children (Berry & Schwebel, 2009). However, our own research with the Hawaii Personality and Health cohort so far is showing associations between childhood personality and self-reported health outcomes but not with biomarkers of health status at midlife, which suggests more complex pathways than hitherto considered (Hampson et al., 2009). A review of studies of associations (or lack thereof), between personality traits and disease onset and progression, and moderators of such associations, would be helpful to guide further pathways research.

The significance of trait change over time for health outcomes is beginning to be apparent (Mroczek & Spiro, 2007). However, there are few studies that have repeated personality assessments over time enabling the modeling of growth trajectories, or latent classes based on similar patterns of growth, and that can relate these changes in personality to health outcomes, perhaps also modeled as latent growth constructs. Mechanisms and pathways are by definition dynamic, so studies of how personality change relates to change in health outcomes are called for.

Conceptualization and Measurement of Conscientiousness

The trait of conscientiousness, as conceptualized in the Five-Factor hierarchical model of personality, is a broad trait encompassing several narrower traits, facets, or trait clusters. Different self-report questionnaires include different selections of these narrower facets (Roberts, Walton, & Bogg, 2005). Some of these narrower traits, such as conventionality (Bogg & Roberts, 2004) or self-discipline (Hagger-Johnson & Whiteman, 2007), may be better predictors of health outcomes than the broad trait and may point to specific underlying explanatory mechanisms. Future research on which narrower traits relate to which health outcomes may be valuable and would benefit from theorizing about the underlying mechanisms involved.

Behavioral indicators of traits. Years ago, Cattell advocated the use of "T" data - responses to experimental situations in the laboratory - in addition to self-report ("Q") and life ("L") data to identify fundamental traits, cross-domain traits. A review of his T data tasks may suggest some methods to re-visit today. Such methods may be well-suited for children who are too young to describe themselves on self-report questionnaires, and these measures are less vulnerable to response bias and faking. Behavioral indicators can be viewed as specific behaviors that are reflections of an underlying trait (e.g., blowing up a balloon to measure risk taking). Such behaviors are selected for their "psychological proximity" (Bog g et al., 2008) with the trait. This is an application of the hierarchical theory of personality traits and their relation to behavior (e.g., Eysenck, 1947). In theory, behaviors are grouped under traits by the features they share with the traits (e.g., Hampson, John, & Goldberg, 1986). However, in practice, we tend to fall back on intuitive similarity, which gives scope for interpretation and subjectivity. (The factor structure of Cattell's T data never aligned well with the factor structure of Q and L data). As a consequence, the same behavioral indicator may be viewed by different researchers as measuring different constructs. For example, Daughters et al. (2005) used the Paced Auditory Serial Addition Task (PASAT) as a measure of "distress tolerance" whereas Gratz et al. (2007) use the PASAT as a measure of "experiential avoidance".

Behavioral indicators of underlying processes. The revival of interest in behavioral indicators reflects increasing emphasis on the hypothesized neural processes underlying personality dispositions. Behavioral measures (e.g., reaction times) are seen as more directly connected to neurobiological mechanisms than self-descriptions. Developing behavioral assessments from this perspective requires formulating theories about the neuropsychological basis of traits. Such an approach has begun for impulsivity.

Problems with impulse control, also known as disinhibition, are characteristic of many psychopathologies and are associated with behavioral problems, including conduct disorder and substance use. Disinhibition holds promise as a mechanism underlying aspects of conscientiousness and their relation to health-damaging behaviors. The regulation of behavior that flows from high levels of conscientiousness, including self-discipline, conventionality, persistence and will power may share the common feature of a mature capacity to inhibit impulses. Temperament and personality approaches to the development of inhibition suggest two forms: reactive, automatic inhibition and intentional, goal-based inhibition (Eisenberg et al., 2009; Nigg, 2000; Rothbart & Ahadi, 1994). Nigg (2000) sees conscientiousness as effortful control. However, the inhibition construct (or metaphor) is itself multi-faceted (Nigg, 2000). There are numerous forms of cognitive inhibition (e.g., interference control, suppression of ideation, suppression of

cued responses) and the tasks used to measure them do not necessarily correlate. It is likely that underlying mechanisms such as attention and disinhibition are related to more than one personality trait and will not clearly discriminate among traits, in much the same way that genes do not map one-on-one to traits. Hence behavioral measures of disinhibition will not necessarily measure a particular traits, but they may tell us about mechanisms through which that trait and others influence behavior.

Behavioral measures of planful control and automatic inhibition may reflect underlying neural processes manifested as conscientiousness. To further this line of inquiry, the question becomes which tasks to select, what to make of the tendency of these tasks to fail to correlate, and how to be confident that they are measuring a tendency for disinhibition with conceptual similarity to low conscientiousness. The feasibility of such tasks for assessment in large research studies or for applied settings (e.g., doctor's offices) should also be considered.

Mechanisms Linking Personality and Health Outcomes

Research on lifespan pathways would benefit from better understanding of the mediating and moderating processes by which personality traits affect behavior. One approach to personality processes is to identify the downstream effects of traits on psychological constructs more proximal to behavior. For example, social cognitive mediation refers to the influence of personality traits on more proximal determinants of behavior such as the constructs in social cognition theories (e.g., the Theory of Planned Behavior) such as attitudes, norms, and self-efficacy (Conner & Abraham, 2001). For example, more hostile children develop beliefs that more of their peers are smoking and drinking, and these increasing descriptive norms predicted their later higher intentions to smoke and drink (Hampson et al., 2006). Conscientiousness has been shown to have a moderating influence on risk perceptions (Hampson et al., 2000). Perceived risk of the combination of smoking in the home and indoor radon predicted a reduction in cigarettes in the home only for those high in conscientiousness. Coping styles are another example of more proximal patterns of behaviors that affect health outcomes and are influenced by personality.

Interventions to Change Conscientiousness and/or its Mechanisms of Effect

Interventions could be designed to change conscientious, or to provide coping strategies to compensate for low conscientiousness. Targeted interventions could be delivered only to those on low on the traits, or generic interventions could be developed that included components specifically for those low on conscientiousness (e.g., providing coping strategies).

Alternatively, greater understanding of the mechanisms underlying the influence of conscientiousness on health outcomes may suggest rather different intervention strategies. For example, social cognitive theory proposed that people develop characteristic adaptations that are in part determined by personality traits. Self efficacy (SE) is one such adaptation, and it tends to correlated negatively with neuroticism, and positively with the other four Five-Factor traits, particularly conscientiousness and extraversion. SE is a general expectation of competence to achieve desired outcomes. An intervention to enhance self-management of chronic illness developed by Lorig and colleagues has been demonstrated to be effective, at least in the short term, and the

effects appear to be mediated by increases in SE (Lorig & Holman, 2003). Franks et al. (2009) showed that this intervention was particular effective for those with high neuroticism and low conscientiousness (these individuals also had the lowest levels of SE at baseline). This is an example of an intervention aimed at changing characteristics downstream from more stable traits.

Behavior indicators (discussed above) may be useful in investigating what has been changed by interventions designed to change conscientiousness or its downstream effects. We may be able to change self-reported conscientiousness (e.g., by changing behavior, resulting changed self-perception), but changing the underlying neurobiological basis of conscientiousness, assessed by a behavioral indicator, may be less likely.

Is there a critical period for conscientiousness to exert its effects on health over the lifespan? This is a potential topic for a review of existing research to evaluate the evidence for a critical period or periods. If such periods were indicated, then the timing of interventions becomes important. For example, Friedman showed a longevity advantage of childhood conscientiousness across the lifespan, indicating the importance of early conscientiousness. Changing conscientiousness or its downstream effects in childhood may prevent the development of chronic illness whereas interventions later in life may be more concerned with slowing disease progression. There may also be critical times in the life course when personality factors play a stronger role, such as around the time of transitions when niche selection provides greater opportunities for dispositional tendencies to direct choices (Park et al., 2009). A more complete understanding of pathways from traits to outcomes should identify intervention opportunities.

Research Directions

The investigation of how personality influences health needs to be addressed using prospective and experimental designs so that causal mechanisms can be inferred with some confidence. Future research may:

- Focus on modeling individual differences in trait change over time, or groups of individuals with similar patterns of change, and relating trait change to health outcomes at different stages of the lifespan. Potential mediators can also be modeled as growth constructs, and rates of change (slopes) of constructs over time examined as possible mediators as well as intercepts.

- Explore ways of integrating findings across existing datasets that address different segments of the lifespan so that pathways can be pieced together.

- Use intervention studies as empirical tests of hypothesized mechanisms of effect. That is, develop interventions that address likely mediating and/or moderating mechanisms identified in prospective studies and evaluate intervention effects on the theoretical mechanisms they are designed to change as well as on health outcomes.

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Conscientiousness and Healthy Aging:
Prepared by Abigail Powers and Bob Krueger

- Twin studies have consistently demonstrated that genetic differences account for 20-30% of overall variation in longevity (Benedictis et al., 2001; Christensen, Johnson, & Vaupel, 2006; Flachsbart et al., 2009). Researchers have also attempted to identify specific candidate genes that relate to longevity. Polymorphisms in both *APOE* and *FOX03A* have been found to predict longevity (Benedictis et al., 2001; Christensen et al., 2006, Flachsbart et al., 2009). However, genetic influences on longevity, as established by twin studies, appear minimal before age 60 (Hjelmborg et al., 2006). This leads to the following questions: *How might personality play a role in the familial influence on longevity at different points in the lifespan? Do the genetic effects on conscientiousness predict the genetic effects on longevity, and might this differ by age?*

- Twin studies have also found that conscientiousness has a moderately high heritability (29-45%), and this contribution appears consistent across cultures (Bergeman et al., 1993; Jang, Livesley, & Vernon, 1996; Luciano, Wainwright, Wright, & Martin, 2006; Yamagata et al., 2006). These studies suggest that the majority of variance in conscientiousness, however, comes from *unshared* environmental effects (53-60%) with little evidence for *shared* environment effects (2-11%) (Bergeman et al., 1993; Jang et al., 1996). *How might these findings affect how we think about personality-related interventions? What does this tell us about the stability or flexibility of conscientiousness?*

- Conscientiousness facets show heritable effects beyond the general heritability of the Conscientiousness trait domain, suggesting that the components of conscientiousness may be affected by specific and distinctive genetic and environmental factors (Jang, McCrae, Angleitner, Riemann, & Livesley, 1998; Luciano et al., 2006). *Which facets are most strongly heritable, and does this have specific implications for understanding the nature of these facets? What aspects of this personality domain are more malleable and what behaviors that relate to a given facet might be most successfully targeted?*

- Although research has demonstrated that health behaviors offer one pathway between conscientiousness and longevity (Martin, Friedman, and Schwartz, 2007), researchers have shown that health behaviors alone do not explain the connection between conscientiousness and longevity (Friedman, 2008). Additionally, the facets of conscientiousness may correlate with different health behaviors (Bogg & Roberts, 2004), suggesting that the relationship between conscientiousness and healthy aging mediated via health behaviors is multilayered. In a meta-analytic review of how conscientiousness is linked to health-related behaviors, Bogg and Roberts (2004) also found that the relationship between health behaviors and conscientiousness may decrease with age. In light

of these findings, *does conscientiousness have differing direct or indirect effects on longevity across the lifespan? For example, is it possibly more influential in predicting health behaviors in younger years but affects coping and illness manifestation in older adults? How might identifying behaviors that relate to specific conscientiousness facets help our understanding of this?*

- The potential impact of chronic stress might also help us understand the association between conscientiousness and longevity. Evidence for the detrimental long term effects of chronic stress (and sustained activation of neuroendocrine systems) on aging is clear (Benedictis et al., 2001; Dowd & Goldman, 2006; Friedman, 2008). *How exactly does personality figure into this connection? Does it influence how much self-selection into stressful situations occurs?* A study by Saudino et al. (1997) explored how personality may mediate genetic influences on life events in the Swedish Adoption/Twin Study of Aging. They found that neuroticism, extraversion, and openness to experience explain all the genetic variance of controllable, desirable, and undesirable life events in women. These results suggest that personality may be one heritable characteristic that affects the type of life events individuals find themselves in. Additionally, the influence personality has on life events may also be different in men and women (Saudino, et al., 1997). *Are the pathways between personality and healthy aging different for men and women?*

- An additional focus in future aging treatment may be on the capacity to alter genes (or gene products, e.g., via pharmacologic means) in a way that promotes longevity. Animal studies examining the malleability of longevity through certain biological markers have shown success in increasing lifespan among mammals. For example, evidence suggests that altering the endocrine function of fat can increase lifespan and insulin sensitivity among mice (Selman et al., 2008). Additionally, mutations of the insulin-insulin growth factor 1 pathway that affect the function of mitochondria appear to increase the lifespan of mice (Christensen et al., 2006). These animal studies also indicate a link between nutrient intake and longevity, suggesting that dietary restriction may interact in a way with genes that promote longevity (Christensen et al., 2006). Animal models could provide us with some basic knowledge of the biological flexibility of humans, and with this knowledge, we may be able to combine personality-related and behavioral interventions that target things like diet (caloric intake). *Could a focus on improving conscientiousness enhance the success of such behavioral interventions? If longevity is malleable, what behaviors or environmental modifications might also promote personality malleability, specifically related to increases in conscientiousness, which could result in useful behavioral changes?*

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White Paper on Disinhibition-related Personality Constructs: Measurement, Intervention, and Directions

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Measurement

The National Institute on Aging has undertaken the important goal of considering the relevance of personality processes as they relate specifically to the process of aging, and with a particular focus on geriatric samples. Much of this work has used the extremely popular and well-validated NEO, focused on the trait of conscientiousness (Costa & McCrae, 1992). This has resulted in important gains in knowledge and prediction of vulnerabilities and strengths as they relate to common problems in later life (See NIA background statement). In expanding the scope of personality assessment, impulsivity, sensation seeking, and risk-taking (including risk taking propensity and risky decision making) are also important for understanding the development of poor mental and physical health outcomes (cf. Zuckerman, 2000), with a large body of research covering early adolescence through young adulthood (e.g., Lejuez et al., 2002, 2005, 2007; Sher, Bathalow, & Wood, 2000). Although levels of these constructs are thought to decrease over time across individuals (see Weiner, Freedheim, Graham, & Naglieri, 2003), understanding problems associated with elevated scores among older adults may be a useful compliment to the existing body of research on the NEO. This is especially likely given the relevance of these constructs to several aspects of the NEO, including neuroticism (specific to the construct of impulsiveness, and hostility to a lesser extent), Extraversion (specific to the constructs of Activity and Excitement-Seeking, as well as Positive Emotions to a lesser extent), Openness to Experience (not necessarily any particular construct but modest links across several), and Conscientiousness (in an opposite direction specific to the constructs of self-discipline and deliberation).

In considering the application of these disinhibition constructs, assessment using self-report strategies is the most convenient and well-validated approach, but as with populations of younger age groups, there are some limitations of using self-report strategies to study these disinhibition variables. Most notably, there are multiple threats to accurate reporting including poor self-evaluation skills, cognitive impairment, an inability to report accurately on personal characteristics, or unwillingness to disclose information that may be perceived negatively by others (cf. Lejuez, Read, Kahler, Richards, Ramsey et al., 2002). Moreover, a strength of behavioral measures is their suitability for repeated use in treatment studies and within-subjects designs (Dougherty, Mathias, Marsh & Jagar, 2005), following appropriate methodological and/or statistical correction for learning effects and test-retest stability (e.g., employing reliable change index or using alternate forms; Halperin, Sharma, Greenblatt & Schwartz, 1991). These measures are sensitive to state-dependent change in behavior, including pharmacological, physiological and environmental manipulation (Dougherty, Marsh-Richard, Hatzis, Nouvion & Mathias, 2008). Possibly most exciting, behavioral measurement provides the opportunity to move beyond description to explanation with the application of neuroimaging techniques (e.g., Li, Lu, DArgembeau, Ng, Bechara, in press; Rao, Korczykowski, Pluta, Hoang, & Detre, 2008) and the development of explanatory cognitive models (Yechiam, Busemeyer, Stout, & Bechara, 2005; Wallsten, Pleskac, & Lejuez, 2005). Indeed personality assessment can be especially powerful when used to isolate the relevant neural and cognitive processes, especially when combined with the ability to see changes in these processes over time or across situations (including emotional evocation procedures). Despite strengths some limitations such as time burden, need for in-person testing in most cases (although some web-based procedures are being

developed to allow for off-site testing), greater vulnerability to practice effects for some tasks, and considerably more limited psychometric data than that available for self-report.

Currently, there are no measures of sensation seeking and recent evidence suggests that the available measures can be organized into three broad behavioral domains: decision-making, inattention, and disinhibition (de Wit, 2009; Reynolds, Penfold & Patak, 2008).

Measure of Decision Making

Kirby Delay Discounting Measure (Kirby & Marakovic, 1996). The Kirby is a widely used and brief measure of delay discounting. The measure consists of 21 fixed choices between a smaller, immediate reward and a larger, delayed reward (Kirby & Marakovic, 1996). The Kirby can be administered as either a hypothetical or real-reward measure. For the real-reward option, the participant is informed that completing the questionnaire will make him or her eligible for a prize corresponding to one of the choices on the questionnaire. Typically one of the 27 choice questions is selected at random and the participant receives whatever he or she chose for that question. Supportive data indicate that substance-using participants who were designated as high in impulsivity on the basis of their clinical diagnoses, demonstrated greater delay discounting than controls. For example, heroin users, smokers, and binge drinkers have all been found to have higher (i.e., more impulsive) discounting rates than healthy volunteers (Kirby et al., 1999; Madden, Petry, Badger & Bickel, 1997; Vuchinich & Simpson, 1998; Bickel & Johnson, 2003; Reynolds & Schiffbauer, 2004). Further, other findings suggest pathological gamblers with substance use disorders discount more steeply than pathological gamblers without substance use disorders (Petry, 2001), suggesting an additive effect. It should be noted that even though the Kirby is largely considered to be a behavioral measure, some believe it shares many key features with self-report measures which will be addressed below.

Experiential Discounting Task (EDT; Reynolds & Schiffbauer, 2004). The EDT is a computerized behavioral task that assesses an individual's propensity to discount the value of a reinforcer as a function of delay (i.e., delay discounting). Until recently, delay discounting measures relied largely on hypothetical question-based paradigms, such as the Kirby. Even though the Kirby differs in important ways form self-report measures, critics of the hypothetical measures have questioned whether hypothetical scenarios based on long delays and large sums of money are ecologically valid, particularly in the absence of choice-contingent consequences and learning (e.g., Critchfield & Kollins, 2001). Consistent with the Kirby and other delay discounting paradigms, the EDT requires the participant to decide between a reward that is immediate and certain but smaller, and one that is delayed and uncertain but larger. Unlike self-report measures, the participant experiences the consequences of his or her choice (including delay, probability and reward from a coin dispenser) before making his or her next choice (Reynolds & Schiffbauer, 2004). The EDT is a forced-choice paradigm, wherein the value of the rewards and the length of the delay vary across trials and choice blocks based on the participant's responses. Therefore, a participant's choices can be used to examine his or her discounting of reward value as a function of increasing delay. Of the two choice options, the delayed standard amount is a larger, delayed and probabilistic reward value (i.e., 30 cents at a 35% chance) against which all other response options are weighed. The only aspect of the delayed standard option that varies across choice

sessions is the delay interval (e.g., 0, 7, 14, 28 seconds). Alternatively, the adjusting immediate option is always delivered immediately and is 100% certain. The value of this immediate option begins at 15 cents (i.e., half the value of the delayed standard option), but it is adjusted by a set percentage during a session according to the participant's choices. If the participant chooses the delayed standard option, the value of the adjusting amount increases for the next choice trial, thus increasing its choice value and making it more attractive for the next choice. However, if the participant chooses the immediate adjusting option, the value of the adjusting amount decreases for the next choice trial, thus making the standard option comparatively more attractive for the next choice. Adjusting the value of the immediate option in this way allows the determination of an indifference point for a given delay to the standard option, which is defined as the reward value of the adjusting option (determined by the participants choices) at which the participant chooses each choice option equally often (i.e., 50% of the time). As evidence of its utility, delay discounting values from the EDT have been found to be steeper among adolescent smokers than non-smokers low in psychopathy traits relative to controls (Melanko et al., 2009), and in adult smokers compared to non-smoking controls (Reynolds, 2006). Furthermore, among adolescents attempting to quit smoking, those who relapsed demonstrated greater discounting on the EDT. Consistent with predictions, participants performed more impulsively on the EDT when they were sleep deprived (Reynolds & Schiffbauer, 2004), and were less impulsive on the EDT following methylphenidate administration in children diagnosed with Attention Deficit Hyperactivity Disorder (AD/HD; Shiels, Hawk, Reynolds, Mazzullo, Rhodes et al., *in press)*. These findings provide support for the construct validity of the EDT, and demonstrate its sensitivity to state-dependent fluctuations in impulsivity.

Balloon Analogue Risk Task (BART; Lejuez et al., 2002). The BART is a computerized measure of risk taking propensity that models real world risk behavior with the potential for reward as well as the risk of harm (Leigh, 1999). In the task, the participant is presented with a small balloon and asked to pump the balloon by clicking a button on the screen. With each click, the balloon inflates .3 cm and actual money is added to the participant's temporary winnings. At any point, the participant has the option to press a button labeled "Collect $$$" which deposits the amount in temporary winnings to the bank (i.e., it can no longer be lost) and ends the trial, at which point new trial begins. However, each balloon is programmed to pop somewhere between 1 and 128 pumps, with an average breakpoint of 64 pumps. If the participant fails to press "Collect $$$" before the balloon pops, all earnings for that balloon are lost and the next balloon is presented. Risk-taking is defined as the average number of pumps on un-popped balloons (Lejuez et al., 2002; Bornovalova, Daughters, Hernandez, Richards & Lejuez, 2005), with higher scores indicating greater risk-taking. In addition, this task provides a measure of latency in milliseconds between pumps number/percentage popped balloons. Young adult data indicate that riskiness on the BART is related to a variety of real world risk behaviors including risky sexual behavior (Lejuez et al., 2002; Lejuez, Simmons, Aklin, Daughters & Dvir, 2004) and risky substance use (Bornovalova et al., 2005; Lejuez et al., 2002; Lejuez et al., 2003; Lejuez et al., 2005; Pleskac et al., 2008). In adolescent studies, performance on the BART (a youth version; Lejuez et al., 2007) was found to significantly correlate with a variety of real world risk behaviors; namely, an increase in RTP is associated with an increased frequency of substance use, gambling, delinquency

behaviors, and risky sexual behavior (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Lejuez et al., 2005; Lejuez et al., 2007). It is notable that relationship of the BART to self-report measures of disinhibition are inconsistent; findings indicate modest, though significant, relationships found with sensation seeking (~ r = .20) , but typically nonsigificant relationships with self-report and other behavioral measures of impulsivity (Bornovalova et al., 2005; Lejuez et al., 2007). More recent work has indicated it can be used to understand the role of neurobehavioral responding and risk behavior using EEG (Fein & Chang, 2008) and fMRI (Rao et al., 2008).

The Iowa Gambling Task (Bechara, Damasio, Damasio & Anderson, 1994). The IGT is a decision-making task, originally developed to examine decisional processes associated with neuropsychological impairment (e.g., Bechara, Damasio, Damasio, & Anderson, 1994; Rogers, Everitt, Baldacchino, Blackshaw, Swainson et al., 1999). At the start of the IGT, the participant is given $2000 and instructed to maximize earnings over the course of 100 decision-making trials. The participant provided with four decks of cards on a computer screen. As described by Bechara et al. (2001), the decks are labeled A, B, C, and D at the top end of each deck. All cards are identical and each card is associated with hypothetical payoffs or losses (although versions with real financial contingencies are available). Cards from decks A and B pay an average of $100 but also contain cards with higher losses, and cards from decks C and D pay an average of $50, but the losses are smaller in magnitude. Accordingly, ten draws from decks A and B (the "disadvantageous" decks) lead to a net loss of $250, while ten draws from decks C and D (the "advantageous" decks) lead to a net gain of $250 (Bechara et al., 1994; Buelow & Suhr, 2009). Several dependent variables from the IGT indicate risky decision making, but the most widely reported indices are number or percentage of disadvantageous choices over 100 trials, where larger values represent greater riskiness. During the task, the participant clicks on a card from any of the four decks. Once selected, the computer emanates a sound similar to that of a slot machine. The selected card appears as either red or black, indicating whether money was lost or gained, and the value of the reward or loss appears at the top of the screen. Following this feedback, the card disappears and the participant selected another card. Each deck of cards is programmed to have 60 cards (30 red and 30 black), although the participant is unaware of how many cards of each type are in each deck. Losses are equally frequent in each deck. The IGT originally was developed as a way to examine the processes underlying real-world decision-making deficits observed in neurologically impaired patients (e.g., Bechara, Damasio, Damasio, & Anderson, 1994; Rogers et al., 1999). However, there is a growing literature to support IGT impairments among clinical groups characterized by impulsive and high risk behavior. For instance, IGT impairments have been found among individuals dependent on alcohol, cocaine, opioids and marijuana relative to healthy controls (Bartzokis, Lu, Beckson, Rapoport, Grant, Contoreggi & London, 2000; Bechara, Dolan, Denburg, Hindes, Anderson et al., 2001; Bechara & Damasio, 2002; Bolla, Eldreth, London, Kiehl, Mouratidis et al., 2003; Bolla, Eldreth, Matochik & Cadet, 2005, Ernst et al., 2003, Goudriaan, Oosterlaan, de Beurs & van den Brink, 2006; Monterosso, Ehrman, Napier, O'Brien & Childress, 2001, Verdejo-Garcia & Perez-Garcia, 2007) with polysubstance users demonstrating even greater impairment (Bechara & Martin, 2004; Grant et al., 2000). Pathological gamblers also have been found to perform more poorly than controls on the IGT (Goudriaan et al., 2006). Findings with regard to ADHD are inconsistent (e.g.,

Ernst et al., 2003; Malloy-Diniz, Fuentes, Leite, Correa & Bechara, 2007). Even more so than BART, a body of evidence suggests the utility of using the task with fMRI to understand the neurobehavioral underpinnings of risky decision making (Bechara, 2003; Konishi, Nakajima, Uchida, Kikyo, Kameyama et al., 1999; Lombardi, Andreason, Sirocco, Rio, Gross, Umhau et al., 1999; Rahman, Sahakian, Cardinal, Rogers, & Robbins, 2001).

Measure of Inattention

*Conners' Continuous Performance Test (CPT-II; Conners, 1994, 2000).*The CPT-II is a computerized measure that assesses the ability to inhibit an ongoing motoric response. Stimuli consist of single letters, which are presented for 250 ms at a variable rate of one every 600-1500 ms. The task consists of 360 trials and requires 14 minutes to administer. Participants are instructed to press the spacebar as quickly as possible in response to each stimulus presentation unless the stimulus is an X. Impulsive responses are defined as errors of commission (i.e., responses to X). Generally, continuous performance tasks require the detection of relatively infrequent target stimuli, and are therefore used as measures of attention, vigilance or executive processing (Strauss, Sherman & Spreen, 2006). In contrast, the CPT-II is considered a measure of impulsivity because it consists of 90% target stimuli (i.e., 90% of trials are letters other than X), which establishes responding as the dominant response, making response inhibition more difficult (Epstein, Conners, Sitarenios & Erdhardt,1998; Edwards, Gardner, Chelonis, Schulz, Flake & Diaz, 2007). As noted previously, errors of commission ("false alarms") are the only dependent variable from the CPT-II thought to reflect impulsivity. However, most validation studies of the CPT-II have examined other performance indices as measures of attention and vigilance deficits associated with ADHD; accordingly there is limited data to support its use as a measure of impulsivity specifically. As general evidence of construct validity, several clinical groups characterized by impulsivity have been found to demonstrate increased errors of commission. The most robust findings come from ADHD samples, where both children and adults with ADHD have been found to make more errors of commission than controls (Malloy-Diniz, Fuentes, Borges Leite, Correa & Bechara, 2007; Rizzo, Bowerly, Buckwalter, Schultheis, Matheis et al., 2002, Losier, McGrath & Klein, 1996). Adults with alcohol dependence demonstrated a similar pattern of deficits (Salgado, Malloy-Diniz, Campos, Abrantes, Fuentes et al., 2009), as did patients with bipolar disorder in the manic, but not euthymic phase of illness (Bora, Vahip & Akdeniz, 2006). Taken together, the CPT-II appears to differentiate among certain clinical groups characterized by impulsivity, providing preliminary support for its construct validity.

Immediate Memory Test and Delayed Memory Test (IMT/DMT; Dougherty, Bjork, Harper, Mathias, Moeller & Marsh, 2003). The IMT and DMT are variations on the continuous performance test paradigm, developed to assess rapid response impulsivity. Like the other continuous performance tests, the IMT and DMT require the participant to respond only when they detect a matched pair of stimuli (a target trial). The IMT requires participants to compare successive stimuli, while the DMT requires participants to compare every fourth stimuli, disregarding three presentations of filler stimuli (Dougherty, Bjork, Moeller, Harper, Marsh et al., 2003). Therefore, there is a 500 ms delay between comparison stimuli in the IMT and a 3500 ms delay between comparison stimuli in the DMT (Dougherty et al., 2003b). Stimuli consist of five digit

numbers, presented for 500 ms at a rate of one per second. The IMT and DMT are administered as a single task, with alternating blocks of IMT and DMT. The entire task consists of 1100 trials (550 of each type), and requires 21.5 minutes to administer. The measure yields two indices of impulsivity: percentage commission errors (i.e., false alarms), defined as responding to a stimulus that matches four of five digits, and the ratio of commission errors to correct detections (henceforth referred to as IMT ratio and DMT ratio). There is considerable literature to support the construct validity of both indices of impulsivity derived from the IMT and DMT. Percentage commission errors and IMT/DMT ratios on both tasks have been found to differentiate patients with bipolar disorder, borderline personality disorder and other personality disorders, and disruptive behavior disorders from healthy controls (Dougherty, Bjork, Huckabee, Moeller & Swann, 1999; Dougherty, et al., 2003a; McCloskey et al., 2009). Among patients with bipolar disorder, IMT and DMT ratios and percentage commission errors have been found to differentiate those with and without a history of suicide attempt; further, among bipolar suicide attempters, patients with more medically severe attempts demonstrated greater impulsivity on the IMT and DMT (Swann et al., 2005).

Measure of Inability to Inhibit Prepotent Responding

Stop-Signal Procedure (Logan, 1994; Logan & Cowan, 1984). The Stop-Signal Procedure is a computerized measure designed to study inhibitory control over an already-initiated response. Logan and Cowan (1984) suggest that inhibitory control reflects competing go and stop processes; behavior depends on the finishing times of each process. If the stop process begins early enough, the response will be inhibited, and if the process begins late, the response will be executed. The Stop-Signal Procedure was developed to examine the conditions under which inhibition is likely to fail or succeed. Stimuli consist of four letters: two are assigned to one response and two are assigned to another response. Participants respond by pressing keyboard keys with the index and middle finger of their dominant hand. Each stimulus presentation is preceded by a presentation of a fixation point for 500 ms. Stimuli are presented for 500 ms at a rate of one every three seconds. The stop signal is a 500 ms, 900 Hz tone, which occurs at one of 10 delays (50-500 ms in 50 ms increments) following the presentation of the target stimulus. The Stop Signal Procedure consists of 800 trials, 25% of which are stop trials. Each delay was used 10% of the time. The measure yields two indices of impulsivity: 1) probability of responding at any given delay, with higher proportions indicating greater impulsivity; 2) stop-signal reaction time, or the latency to respond in stop-signal trials, with slower (larger) response times indicating greater impulsivity. Stop-signal reaction time cannot be observed directly, and is therefore derived. Logan and colleagues have proposed an alternate stop-signal procedure to estimate this value (Logan, Schachar & Tannock, 1997; the reader is referred to Logan & Cowan, 1984 for the standard computational methods) using adjusting values for the delays, based on the participant's performance. That is, the delay increases by 50 ms if the participant inhibits successfully, and decreases by 50 ms if the participant responds, eventually converging on the delay interval at which the participant inhibits correctly 50% of the time. This value represents the estimated stop-signal reaction time. There is considerable data supporting the Stop Signal Paradigm in sample such as adults with ADHD (Bekker, Overtoom, Kenemans, Kooij, De Noord et al., 2005; Lampe, Konrad, Kroener, Fast , Kunert et al., 2007; Chamberlain, et al., 2007; Aron, Dowson, Sahakian & Robbins, 2003) pathological

gamblers with a history of childhood ADHD (Rodriguez-Jimenez, Avila, Jimenez-Arriero, Ponce, Monasor et al., 2006), and dependent users of a variety of drugs including cocaine, alcohol, and methamphetamine (Fillmore & Rush, 2002; Monterosso, Aron, Cordova, Xu & London, 2005; Goudriaan, Oosterlaan, de Beurs & van den Brink, 2008). Deficits on this task also has predicted poor treatment outcome for gamblers (Goudriaan et al., 2008) and obese children participating in a weight reduction intervention (Nederkoorn, Jansen, Mulkens & Jansen, 2006).

Intervention

In considering these personality issues, there are inherent difficulties in developing interventions. Even if personality is inherently malleable, the question is how malleable is it in the context of treatment. Two approaches take a slightly different approach and are worthy of consideration.

Contingency Management (CM). Several of the behavioral assessment measures outlined above are based on the idea that impulsive and risky behaviors persist because the negative consequences are delayed, as are the positive consequences of more positive healthy behavior. CM uses contrived reinforcers to mediate these delays, with much of the research aimed at drug use. Specifically, participants are urine tested daily for evidence of drug use and paid a small amount for "clean" urines. With each successive clean test, the payment amount is increased. However, a single dirty urine then means no payment for that day and a return to the previous payment amount. Therefore, the delay to punishment for unhealthy behavior is dramatically removed as is the delay for the immediate positive consequences of healthy behavior. Unfortunatley, when the payment system is stopped almost all the gains are immediately reversed. A description of the treatment and the issues raised above are reviewed by Stitzer and Petry (2006). Some have argued that this abrupt loss of effectiveness occurs because the money helped the individual temporarily inhibit impulsive and risky behaviors but with this treatment not addressing long-term functional alternatives, it is not surprising that the unhealthy behavior re-emerges. For this reason there is value in a companion treatment that addresses function. One approach that has been used is the Community Reinforcement Approach (Hunt & Azrin, 1973) which is an elaborate strategy for providing skills to the individual and to help him/her make positive environmental changes. Below I will discuss a more recent approach that is considerably shorter and less intensive. Somewhat surprisingly, little research has examined if CM produces any temporary or long-term changes in the individuals level of impulsivity or risk taking across other domains.

Behavioral Activation. It is possible that providing behavioral alternatives, ones that address the same functional needs as impulsive and risk behaviors could have value. One approach is behavioral activation. This traditionally has been an approach to target depression (Jacobson et al., 1996; Lejuez, Hopko, and Hopko, 2001), but recently has been used to target impulsive and risky behaviors (see below for examples). The goal of this approach is to help individuals become more aware of their values and then provide structure and support to find more effective strategies to get those values met with functionally relevant behaviors on a daily basis. The key component to accomplish this is daily planning and monitoring or behavior. So unlike other approaches that might endeavor to change the impulsive and risk taking personality, BA tries to find a functionally meaningful alternative without the negatives. Similar to CM, the monitoring

by the patient and focus on this in session by the therapist provide some of the immediate benefits for positive behavior and immediate punishment for less effective behavior. Over time this may lead to reduced impulsive and risky tendencies but it doesn't need to do so to be effective. Published evidence suggests this approach can limit treatment dropout among low income cocaine and heroin users (Daughters et al., 2008; Magidson et al., in preparation), can improve smoking cessation outcomes (MacPherson et al., in press), can reduce problem drinking among college students, and reduce problematic eating (Pagoto et al., 2008). Unfortunately, the role of BA traditionally has been focused on the mood related deficits and less on the role of disinhibition. For this reason, measures of impulsivity, sensation seeking, or risk taking haven't been collected leaving unclear whether behavioral changes occur independently or in line with disinhibition-related changes.

Directions

Research using the NEO has indicated the importance of understanding personality processes in aging. The goal of this white paper was to identify disinhibition processes as important compliments for assessment. Two particular issues highlighted here are the benefits of behavioral measurement (not as a replacement but as an addition to self-report measurement) and the link to treatment. There are several exciting possibilities in applying this work in geriatric samples. However, in doing so it is important to tie this work back to what already has been done in a complimentary manner. One particular direction is the consideration of how other relevant traits such as conscientiousness could be studied behaviorally (including the development of behavioral tasks specifically measuring conscientiousness and related processes) or be added as a consideration in the application of the treatments mentioned above to ensure these treatments include a focus on factors known to be important among geriatric samples.

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New Frontiers for the Study of Conscientiousness, Health, and Aging

The importance of conscientiousness to both health and positive aging appears indisputable. Conscientiousness predicts most of the major preventative and risk behaviors for both physical health and mortality (Bogg & Roberts, 2004). Conscientiousness also predicts physical health itself. For example, lower conscientiousness was associated with diabetes, high blood pressure, skin problems, strokes, ulcers, and tuberculosis (Goodwin & Friedman, 2006). Similarly, of the Big Five, conscientiousness was the best personality trait predictor of illness burden (i.e., physician quantified morbidity) even when controlling for education, substance abuse, hypertension, and cholesterol (Chapman, Lyness, & Duberstein, 2007). Similarly, childhood ratings of conscientiousness predict midlife health ratings independent of social environmental effects such as education and health-related behaviors (Hampson, Goldberg, Vogt, & Dubanoski, 2007). Conscientiousness has even shown to predict slower disease progression in HIV patients (Cleirigh, Ironson, Weiss, & Costa, 2007). And, finally, conscientiousness has been shown repeatedly to predict longevity (Roberts et al., 2007).

Now that the importance of conscientiousness as a domain has been established, it is important to move to a second generation of studies that will move the science of the study of conscientiousness foward. Below, we describe four goals for research on conscientiuosness, health, and aging that reflect projects we are either working on or hope others will pursue.

Refine and Expand Methods of Assessing Conscientiousness

One of the primary challenges confronting the study of conscientiousness is how to assess the trait. This challenge breaks down into two subsidiary, but related challenges: what are the constituent elements of the domain and how can we improve our measurement of the trait? These questions clearly apply to conscientiousness and should be addressed systematically going forward.

We have done preliminary work on both of these questions, but have yet to arrive at a satisfying answer to either. In terms of the constituent elements or facets of conscientiousness, we have conducted several studies aimed at identifying the potential underlying structure of conscientiousness. Using both lexical and inventory approaches, we have arrived at a preliminary 5-facet model of conscientiousness that includes the facets of organization, industriousness, self –control, responsibility, and conventionality (Roberts et al., 2004; 2005). This structure is based on only two studies to date and needs further investigation and confirmation.

We have also attempted to identify alternative methods that might be used to assess conscientiousness. To this end, we have examined observer ratings of personality and experimental tests that are conceptually consistent with conscientiousness (Lodi-Smith et al, in press; Edmonds et al, 2009). The results of these studies are very clear on three fronts. First, alternative methods of assessing conscientiousness are only modestly related to one another. The level of convergence across methods makes it unclear whether these different methods are assessing the same construct. Second, *there appears*

to be no ideal method to assess conscientiousness. Despite the fact that putative measures of conscientiousness do not converge across methods, each method affords the same approximate level of validity when predicting health and health-related outcomes. Third, and possibly more importantly, *alternative methods of assessment often provide incremental validity*. For example, observer ratings of conscientiousness predict health outcomes over and above self-reports of conscientiousness. Likewise, experimental approaches to assessing conscientiousness, such as performance on go-no go tasks, also provide incremental validity over self-reports.

The conundrum that these results engender is how to reconcile the lack of correlation across methods with the convergent validity of each method on outcomes that are theoretically linked to conscientiousness. We have little or no theoretical or conceptual reason to expect this pattern and no interpretive framework to reconcile the apparent contradictions. We believe that a comprehensive, systematic approach to measurement issues is paramount to improving the science related to linking conscientiousness to health. Achieving a better understanding of the meaning of the various methods for assessing conscientiousness will provide better information on other critical issues, such as which aspect of conscientiousness is the most important for health outcomes. In addition, we believe work should also address the basic psychometrics of the assessment process using techniques such as Item Response Theory to test the underlying models we use to assess conscientiousness regardless of the method we employ.

Determine Whether and How to Change Conscientiousness

Much of our research to date has focused on the longitudinal patterns of continuity and change in conscientiousness, and other personality traits, across the life course. Our research has shown that, like other traits, conscientiousness is moderately consistent over long periods of time (7 years) and shows systematic increases largely in young adulthood but also in midlife and old age (e.g., Roberts & DelVecchio, 2000; Roberts, Walton, & Viechtbauer, 2006). We have also identified several correlates of change in conscientiousness, such as occupational success, marital stability, and counterproductive work behaviors. Occupational success and marital stability are associated with increases in conscientiousness, and counterproductive work behaviors are associated with decreases in conscientiousness.

Applying these findings to health brings two research agendas to mind. First, we need to test whether and to what extent changes in health are linked to changes in conscientiousness. Given the importance of conscientiousness to health and healthy aging, one of the implications of changes in conscientiousness is that increases will impart subsequent improvements in health especially in old age. By increasing in conscientiousness, people may not only be adding more years to their lives, but better quality years as they will be healthier during that time. Of course, we will need appropriate longitudinal epidemiological research to test this idea.

One of the ambiguities of passive longitudinal research is the inability to determine causal direction. In the case of changes in conscientiousness and health, it could be that changes in conscientiousness cause changes in health, changes in health cause changes in conscientiousness or both. We believe it would be prudent to pursue two programs of research on interventions in order to tease some of these issues apart.

First, it would be relatively straightforward to embed measures of conscientiousness in ongoing intervention studies focusing on changing health behaviors. For example, if an intervention successfully changes exercise behavior, one unintended consequence (non-specific treatment effect in the parlance of clinical psychology) would be that these individuals would also increase in conscientiousness. This type of study would provide a test of a "bottom-up" model of change, in which changes at the more molecular level of behavior are translated into the person's personality.

Alternatively, one can try to change conscientiousness directly. Several previous studies based on clinical interventions have shown that personality traits respond to clinical interventions (De Fruyt et al, 2006). In addition, a recent intervention study intended to increase "mindfulness" in medical doctors showed non-specific treatment effects on conscientiousness (Krasner et al., 2009). A potential high risk, high reward program of research could identify potential ways of increasing conscientiousness and building training interventions to test these ideas. These interventions could then be employed with several different populations to see if they are efficacious in groups drawn from various ages, such as children, young adults, and the aged.

In addition to creating and testing techniques for changing conscientiousness, we believe that these studies should move beyond past research in two ways. First, all of the previous research focused on interventions to change conscientiousness has relied on self-reports of conscientiousness. It would be more convincing to show that observer ratings or experimental procedures tapping conscientiousness also change. Second, these studies would need to be long term so as to show that the gains made remain in place for an extended period of time. It could be that the previous research has simply shown state fluctuations in conscientiousness and not changes in the more stable structure of the trait of conscientiousness.

Determine the Epidemiological Significance of Conscientiousness

Numerous epidemiological studies have shown the importance of single health behaviors, such as smoking, eating specific foods, and doing certain forms of exercise. Inevitably, these studies go on to mention that the individuals who practice specific health related behaviors tend to possess a profile of attributes, such as being more highly educated, thinner, more knowledgeable of health issues, etc, that are often characterized as a healthy lifestyle or the healthy-user bias.

Similar issues also arise in randomized placebo control trials. For example, in one study it was found that a new statin was surprisingly ineffective in reducing cholesterol levels. The authors of the study proposed that the results were biased by lack of adherence to the medical protocol, with some individuals being more diligent and persistent in taking their medications, and others being less diligent. When the cholesterol levels were conditioned against adherence, the researchers found that individuals who adhered more diligently to the medical prescription regimen had lower levels of cholesterol. This finding was reassuring until the researchers ran the same analysis on the control group. The participants who more diligently adhered to the medical protocol in the placebo group also had better cholesterol levels (Coronary Drug Project, 1980).

The obvious inference one can draw from these unrelated studies is that the typical epidemiological study is confounded by personality and the trait of

conscientiousness in particular. This possibility is bolstered by a recent study in which it was found that attrition in long-term epidemiological studies could be predicted by personality traits, in particular conscientiousness (Jerant et al., 2009). Thus, conscientiousness may be an unmeasured third variable confounding much of the epidemiological literature—both the long-term correlation studies as well as the randomized placebo control trials. This possibility invites the obvious conclusion that we need a systematic investigation of the role of conscientiousness in the adherence process as well as incorporation of personality measures in ongoing epidemiological research to determine whether personality can explain the healthy-user bias noted in much epidemiological research.

Determine the Physiological Architecture Underlying Conscientiousness

Recent research has shown that high conscientiousness is a protective factor for Alzheimer's disease (Wilson, et al., 2007). People who were more conscientious were less likely to experience cognitive decline in old age and subsequently experience Alzheimer's disease. The finding, now replicated, is interesting in its own right, but what is quite possibly more interesting is the fact that this relationship held up even when a comprehensive profile of social environmental and health behavior variables were controlled for in the prediction of Alzhiemer's. To date, the modal approach to understanding the effect of conscientiousness on health is through its effects on social environmental factors, such as educational attainment, and health behaviors, such as diet and exercise. The fact that these latter variables failed to mediate the relation between conscientiousness and Alzheimer's disease invites the possibility that previously unidentified physiological mechanisms might explain the relation between conscientiousness and the neurological factors underlying Alzheimer's disease.

The possible neurophysiological factors that might explain the relation between conscientiousness and medical phenomena such as Alzheimer's disease remain unclear. One possibility is that conscientiousness directly affects the neurological architecture also implicated in diseases like Alzheimer's. Unfortunately, there is very little direct evidence linking conscientiousness to brain structures. For example, to date only a handful of studies have examined the relationship between event related potentials conscientiousness. Generally, these studies show that P3 amplitude is positively related to conscientiousness (Guerra et al., 2001; 2004). Similar, there has been little work done using FMRI techniques and normal personality. In one case, persistence, a component of conscientiousness was related to activation in the Precuneus, Paracentral lobule, and Parahippocampal gyrus (Gardini, Cloninger, & Venneri, in press).

These studies point to the possibility of identifying the underlying brain circuitry associated with conscientiousness. Pursuing similar research would be beneficial from several perspectives. First, it may reveal some of the potential neurological pathways through which conscientiousness protects individuals from disorders, such as Alzheimer's disease. Second, research identifying the neural circuitry may help narrow the search for genetic and hormonal mechanisms that contribute to varying levels of conscientiousness. Prevailing research on the genetics of personality traits, such as conscientiousness, is predominantly exploratory, largely because we have yet to identify the physiological systems responsible for individual differences in conscientiousness.

Conclusion

To conclude, we are intrigued by the possibility of a comprehensive focus on conscientiousness, health, and aging. The four agendas described above are only four of many different possibilities. For example, we also believe that identifying the genetic and environmental etiology of conscientiousness is of paramount importance. It is disconcerting just how little we know about the processes that lead to the development of conscientiousness. We also believe that it would be important to map the interface between the "normal" personality domain of conscientiousness and dimensions typically identified as part of psychopathology, such as the qualities associated with the externalizing spectrum or defense mechanisms. The types of goals outlined above are achievable through a systematic, collaborative program of research that crosses interdisciplinary boundaries. We hope that the National Institute of Aging meeting on conscientiousness, health, and aging will help foster the research necessary to achieve these goals.

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The Background Statement prepared by David Reiss and his colleagues identifies conscientiousness (hereafter "C") as perhaps the key aspect of personality that is related to manifold dimensions of health. Nevertheless, as assessed by the NEO inventory, C likely accounts for less than 5% of the variance in mortality and other central indicators of health. This paper suggests several opportunities and challenges in the study of links between C and health when considered from the perspective of genetically-informed sociology.

1. CONCEPTUALIZATION AND MEASUREMENT

A. Identification of Endophenotypes. As Johnson and Krueger (2004) note, different dimensions of C likely reflect different genetic mechanisms. Further, it may be that C reflects endophenotypes, relatively immediate products of genetic action that, in turn, lead reliably to C's dimensions as conceptualized and measured by, for example, Costa and McCrae. By identifying links between genetic clusters, endophenotypes, and dimensions of C, research into C could be firmly based in the biological bases of behavior.

One candidate for such research, for example, is impulsivity. My own work focuses on TaqIA, a locus functionally related to dopamine receptor type 2 and thought to be related to impulsivity based on non-human animal models and research on humans, including fMRI studies. Impulsivity comprises several distinct dimensions, including novelty-seeking (compare C's dimension of self-discipline), behavioral disinhibition (compare C's dimension of dutifulness), and nonplanning (compare C's dimensions of personal organization and achievement striving). Frank and his colleagues (2009) show that TaqIA is related to No-Go Learning, the capacity to learn from aversive experiences.[2] Another gene candidate for a C endophenotype is DRD1, which is thought to be related to Go-Learning, the capacity to learn from rewarding experiences. In any event, future research should consider whether hard-wired – though malleable— differences in learning, perception, and affect may actually be endophenotypes related to C. Such research could be conducted with experimental designs, although it would be most informative to extend such work into "naturalistic settings" such as classrooms, families, and workplaces.

B. Importance of Behavioral Measures. Some evidence suggests that self-reports of impulsivity may be limited, however. Eisenberg et al.'s (2007) study of the link between TaqIa and impulsivity assessed both a standard behavioral measure (the delayed discounting task) and three well-established survey instruments that resulted in eleven scales that tapped global and dimensional aspects of impulsivity. TaqIA was significantly associated with the behavioral measure but none of the eleven measures based on self-reported items. Similarly, dopaminergic genes have been associated with another behavioral measure (the stop-signal task) but not self-reported items (Congdon & Canli, 2008). Reflecting findings such as these, Epstein's (2006) review of the molecular genetic bases of personality concludes that self-reports have distinct limitations when

[2] Based on this finding, I hypothesized that TaqIA would be related to educational processes, which has been empirically supported (Shanahan et al., 2008). Animal KO studies suggest that TaqIA is related to hypertension, so I am presently studying TaqIA-education-hypertension links in humans.

assessing constructs related to impulsivity and indeed C itself. Thus, behaviorally-based measures of C—ideally that can administered to large numbers of people—would be most helpful.

2. MECHANISMS LINKING CONSCIENTIOUSNESS AND HEALTH

A. SES, Conscientiousness, & Health. Socioeconomic status (SES) represents one of the major sources of health inequality in the United States and for, many indicators of health, education is thought to the be key explanatory component of SES. In turn, many ideas have been advanced for the mechanisms linking highest educational degree (less often, grade level) and such outcomes as hypertension, diabetes, cholesterol levels, and mortality. For example, Miech and his colleagues (2009) analysis of NHANES data from 1989 to 2005 showed that for those adults with less than a high school education, the rate of diabetes-related mortality increased by 75% among those aged 40–64 years and by 40% among those aged 65–79 years. In contrast, in the highest education category (at least a college degree) the rate decreased for both age groups, by 7% among those aged 40–64 years and by 15% among those aged 65–79 years.

The mechanisms linking education and health include belonging to social networks that encompass access to high quality physicians (including specialists); searching out and internalizing the latest medical advice; adopting new medical technologies quickly; and being aware of health risks and behaviors that promote health. By virtue of these factors and higher incomes, the highly educated are also more apt to have health insurance. Some of these mechanisms are likely reflected in Miech et al.'s finding that education was also related to increasing disparities in glucose control (as indicated by HbA1c levels > 8%) and co-morbid cardiovascular problems such as hypertension.

However, such research has not considered the possibly critical role of C. Indeed, there are three plausible possibilities. First, perhaps education is most efficacious when coupled with C. According to this view, people with advanced skills in seeking out and processing health information will benefit, in terms of health, but they will benefit much moreso if they also possess high levels of C. (The alternative interpretation—that people with high levels of C benefit in terms of health, but markedly moreso when they also have advanced educations—is also *a priori* plausible.) A second possibility is that education mediates the link between C and health. That is, C promotes educational achievement, which in turn is related to better health. Finally, it may be that the education-health link is actually spurious, reflecting C. This intriguing hypothesis posits that C causes both education and health (somewhat loosely speaking), relationships which account for the association between education and health that in fact reflect no linking causal mechanisms. These three hypotheses are not mutually exclusive and may each be non-negligibly true to some degree. Thus, C causes change in education, which mediates some, but not all, of the association between C and health and, whether referring to the direct or mediated associations, there will be an interaction between C and education in predicting health.

B. Conscientiousness in the Life Course. Clausen formulated a construct, "planful competence," that is closely related to the NEO's conceptualization of C. His motivation in creating yet another approach to personality was to identify those aspects of personality that mattered most to the life course, which refers to the sequence of inter-connected statuses and roles that extend from birth to death. Accordingly, planful

competence was intended to capture inter-individual variation in how well the individual can assess his/her strengths and weakness, identify opportunities that match these strengths and weaknesses, and then formulate and pursue short- and long-term plans to realize these opportunities. (Clearly, such a construct intersects in significant ways with Costa and McCrae's NEO construct, with its focus on competence and self-efficacy; personal organization; dutifulness and fulfilling obligations; achievement striving; self-discipline; and deliberation.)

Planful competence has been criticized as a "unitary construct attempting to accomplish too many things" and rightfully so. However, Clausen advanced an intriguing hypothesis: inter-individual differences in planfulness at about age 16 were decisive in the later life course. He reasoned that it was planfulness in the late teens that drove major commitments to the beginnings of educational, occupational, and family careers. That is, youth differ in how well they can make decisions that bear on their adult lives and these differences cast a long shadow over how much education one receives, work careers, family life, and, in turn, health. Clausen's analysis of the Bay Area Studies provided support for these expectations: planfulness at age 16 was a rather strong predictor of later life course patterns. My own (with Elder, 2002) analyses of the Terman sample confirmed Clausen's findings, although they also suggested that self-conceptions in adulthood independently predicted indicators of adjustment to work and family.

All of this empirical research may be criticized on psychometric grounds. At the same time, Clausen advanced an intriguing conceptual model for which there is preliminary supportive evidence and which may bear on the salience of C to health: inter-individual differences in C in late adolescence early adulthood are especially salient in predicting health through adulthood. This hypothesis reflects two mechanisms. First, it is during this time that many people develop health-related behaviors and begin to engage in risky/health-related behaviors that may be habit-forming (e.g., alcohol, tobacco, exercise, diet). Perhaps highly C people make better choices at this early point in such trajectories, which in turn has life-long implications, Second, highly C youth may make better choices with respect to school, work, and family, and thus decrease their life-long stress burden. For example, planfulness was found to be related to marital and occupational instability, which could be highly stressful. By both mechanisms, C in youth influences "initial states" of pathways that then begin to diverge and lead to very different health outcomes.

This hypothesis is intriguing but somewhat limited in its unidirectional view of C predicting health. Future research should also investigate environmental features that promote and then reward C behaviors. A very large body of research documents that key aspects of personality reflect one's upbringing and influence selection into occupational categories; in turn, experiences at work strengthen these initial dispositions, resulting in feedback cycle with self-strengthening tendencies. Can such processes be observed with C such that specific environmental features reward C and C leads to selecting environments with such features later in life? And if these tendencies are observed, do such people exhibit better health because of these dynamics?

In addressing all of the above questions, it will be especially informative to compare and contrast different aspects of health based on their etiological processes. Perhaps some indicators of health are more responsive to C than others. As hypotheses about fetal programming proliferate, it would be especially interesting to look at the role

of C in promoting health among individuals who were raised in adverse early environments.

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